Consulting Electrical Engineers Association of Maharashtra

CEEAMA *Live Wire*

E-NEWSLETTER

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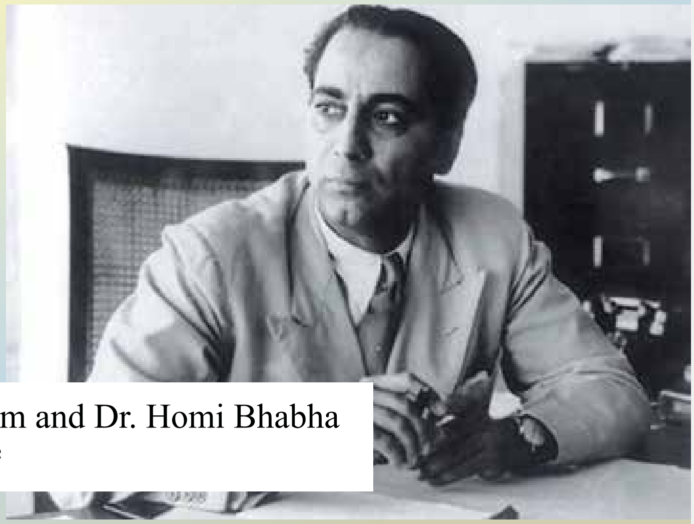
CEEAMA Annual General Meeting was conducted on 16th September at Rabale, Navi Mumbai



Scientists born in October - Dr. APJ Abdul Kalam and Dr. Homi Bhabha
More about them inside

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Chief Editor - CEEAMA LIVEWIRE

From the Editors Desk,

The Indian festivities started off with a leap on the moon. All Ganesh mandals & households' decorations started depicting the Moon, the Stars, the Chandrayaan, the galaxy and all felt within one's reach. I am sure the forthcoming Navratri, Dashera, & Diwali festivals would be even more exciting and scintillating with entire nation celebrating India's maiden solar mission viz. Aditya L1 which was successfully launched from Satish Dhawan Space Centre, Sriharikota by ISRO on 2 September, 2023.

CEEAMA's much awaited AGM was successfully conducted in full quorum at Rabale, Navi Mumbai at Hotel Vista Inn, thanks to our sponsors Mr. Sony Jacob of Power-Matrix who also arranged a short visit to his factory nearby where production of world-class Harmonics Filter panels are in full swing.

We were honoured to receive our senior LFM, guide, mentor and a big blessing in the form of Hon. Shri Gadre-sir who took us down the memory lane of first CEEMA meeting way back in 2004 at Hotel Kohinoor in Mumbai. He also brought to our attention his vision for CEEAMA in the form of succession plans, volunteering, knowledge sharing and future growth. Our outgoing president, Mr. Narendra Duvedi also addressed the AGM as he rushed down from Pune after delivering his speech at the EPS Business meet on Empowering the future: Innovations in Electrical, Power, and Solar technologies.

The AGM unanimously re-elected some of the directors retiring by rotation. Some of the other topics covered included: a) Next CEEAMATECH (theme: Solar, location: Lonavala), b) NEC 2023, c) focus on Membership growth, d) invitation to Mr. Ghosh for GC, etc.

Sumptuous dinner at the same location concluded the AGM with members' heart-warming adieu!

On the same note, let me wish you all again a very glittery festivity season bringing prosperity, health & happiness in each one of your lives!

Subhash L. Bahulekar

Chief Editor – CEEAMA

From the President's desk:

Hello friends.

I thank all the members present on 16th Sep for CEEAMA's 12th AGM held at Vista Inn, at Rabale, Navi Mumbai. Due to the support of all members, all resolutions were passed unanimously. I also thank Mr. Sony Jacob of Power Matrix Solutions for sponsoring the program and arranging for the visit to his works.

With this I appeal all our LFMs and AMs to share their Articles on Power Quality for the November Issue.

Mr. Veejhay Limaaye

Hon. President

CEEAMA

From the Secretary's desk:

Dear friends,

We received very encouraging feedback on the 'LiveWire' launched last month, which has prompted us to do better this month. Hope this issue dedicated to Cables and Cabling practices keeps you engaged and inspires you to excel in your profession.

While cabling is inevitable in any electrical engineering project, I realised that researching on cabling practices can indeed pose several challenges due to the complexity and evolving nature of the field. The field of cabling and network infrastructure is constantly evolving with new technologies and standards emerging regularly. Keeping up with the latest developments can be challenging for engineers. Cabling installation practices are applicable at all projects. Power transmission, telecom, industrial distribution and automation, commercial and residential networks – you name it. Each application has its own specific requirements and standards, making it challenging to cover all aspects comprehensively.

While planning for cabling in our projects, we need to adopt a multidisciplinary approach, collaborate with industry experts and stay actively engaged with standards and the academic references as well as cable manufacturers. Sharing of experience and lessons is quite vital to ensure learning from mistakes by others.

While on the subject we encourage all members, associate members and patrons to contribute with their technical articles on electrical engineering subjects. They may be on any topic in this vast field, and not necessarily related to a particular theme. We will be glad to publish the articles so that our community at large is benefitted. Additionally, sharing of experience helps in contributing to widening of our vision and reaping benefits from it.

Next month we focus on Power Quality, Capacitors and Harmonic Filters. Let's keep the sinewave perfect - the smooth operator of the electrical engineering world.

Till the next month, Happy Navratri and Dasara in advance.

Mr. Chidambar Joshi

Hon. Secretary

CEEAMA

Fire Resistant Cables - Applications and Testing

Abstract

There are many new enquiries in the market regarding Fire Retardant cables as well as Fire Resistant cables. Upon checking with the consultants and owners, sometimes the specifications get changed leading to cost escalations and inconvenient delivery times. This article aims at clarifying some aspects of Fire-Resistant cables by comparing them with Fire-Retardant cables. Special testing requirements of the Fire-Resistant cables are also covered in the article.

Introduction

Fire-resistant cables, often referred to as fire-rated cables, are specialized electrical cables designed to maintain their functionality and structural integrity during a fire for a specified period of time. These cables are commonly used in buildings, industrial facilities, and critical infrastructure to ensure that essential electrical circuits remain operational in the event of a fire. Fire-resistant cables are commonly used in applications such as emergency lighting and power systems, fire alarm systems, and essential equipment where electrical power must be maintained during a fire. The applications also include cables to staircase pressurisation fans, fire lifts and other recommended areas as per Chief Fire Officer's and Municipal requirements. Fire-resistant cables are thus an important component of fire safety systems and emergency response plans.

Key characteristics of the fire-resistant cables are as follows

Fire Resistance: Fire-resistant cables are designed to withstand high temperatures and flames. They are constructed using materials that have a high resistance to fire, such as special insulation and sheathing materials.

Circuit Integrity: The primary function of fire-resistant cables is to maintain electrical continuity during a fire. This means that even in the presence of extreme heat, the cable will continue to carry electrical current, ensuring that essential equipment and systems remain powered.

Low Smoke Emission: Fire-resistant cables typically produce minimal smoke when exposed to fire, which is important for the safety of occupants during evacuations. Reduced smoke production helps maintain visibility and ensures that smoke detectors can function effectively.

Low Toxic Gas Emission: These cables also minimize the release of toxic gases when exposed to fire. Toxic gases can pose significant health hazards to people in the vicinity of a fire.

Certification Standards: Fire-resistant cables are often tested and certified according to specific industry standards, such as IS 17505, IEC 60331 and BS 6387, to ensure their performance in fire conditions. The certification indicates the duration for which the cable can maintain its fire resistance.

Applications of the Fire-Resistant Cables

Emergency lighting and power systems: To provide illumination and power to critical areas during a fire or power outage.

Fire alarm systems: To ensure that fire detection and alarm systems continue to operate.

Emergency communication systems: To maintain communication capabilities during emergencies.

Essential equipment: For critical machinery, control systems, and safety systems that need to function during a fire. This may include basement jet fans, smoke evacuation systems, pressurisation systems etc.

Differences between Fire-resistant cables and Fire-retardant cables

It is important to note that fire-resistant cables are not fireproof cables, as no cable can be entirely fireproof. Instead, they are designed to resist fire for a specified period, allowing for continued operation of essential systems and safe evacuation. The choice of fire-resistant cables depends on the specific requirements and Government regulations applicable to the installation, as well as the expected fire conditions.

Fire-resistant cables and fire-retardant cables are two distinct types of cables designed to address different aspects of fire safety.

Fire-Resistant Cables:

i. Functionality During Fire: Fire-resistant cables are designed to maintain their electrical functionality and structural integrity during a fire. They can continue to carry electrical current even when exposed to high temperatures and flames, ensuring that essential electrical circuits remain operational.

ii. Circuit Integrity: The primary focus of fire-resistant cables is to ensure the continuity of electrical circuits, allowing critical equipment and systems to function during a fire, which is essential for safety and emergency response.

iii. Certification Standards: Fire-resistant cables are typically tested and certified according to specific industry standards (e.g., IS 17505, IEC 60331, BS 6387), indicating the duration for which they can withstand fire conditions while maintaining their functionality.

iv. Fire withstand temperature: Fire-resistant cables are designed to withstand extremely high temperatures during a fire, typically in the range of 800°C to 1,000°C (1,472°F to 1,832°F) or even higher.

v. Construction: Fire-resistant cables are constructed with special materials and design features that enable them to withstand high temperatures and flames. These materials are typically made of inorganic or mineral-based compounds that can withstand extreme heat without catching fire e.g. mica tape, ceramic fiber, silicone rubber etc. Fire-resistant cables often have a layer of metallic armor or tape, such as steel or aluminum, to protect the cable's core from damage.

Fire-Retardant Cables:

i. Spread of fire: Fire-retardant cables are designed to slow down the spread of fire along the cable itself. While they can delay the progression of a fire to some extent, they are not intended to maintain electrical functionality during a fire.

ii. Reduced Flame Spread: Fire-retardant cables are typically coated or treated with fire-resistant materials that inhibit the cable's ability to support or propagate flames. This can help prevent the cable from becoming a source of ignition and reduce the risk of fire spreading through the cable.

iii. Applications: Fire-retardant cables are often used in areas where there is a concern about the potential for cable fires, such as in building construction where they are installed within walls, ceilings, or floors to limit the spread of flames in case of a fire. They are not typically used in critical applications where uninterrupted power is required during a fire.

iv. Fire withstand temperature: Fire-retardant cables are designed to resist catching fire easily and typically have a lower temperature withstand range compared to fire-resistant cables. They can typically withstand temperatures up to around 70°C to 90°C (158°F to 194°F) during normal operation.

v. Construction: Fire-retardant cables are constructed with materials that resist catching fire easily and that emit minimal smoke and toxic fumes when exposed to flames. These materials are designed to self-extinguish when the heat source is removed. Common materials include PVC (polyvinyl chloride) and low-smoke, zero-halogen (LSZH) compounds.

Steps taken to test fire-resistant cables

Fire testing methods and building safety standards often define specific fire safety requirements applicable to cables. The construction of Fire Survival cables is different compared to ordinary cables. The conductor is manufactured with a specially designed heat barrier and fire-resistant insulation which resists the fire to reach conductor surface.

Testing fire-resistant cables is an important part of ensuring their reliability and compliance with industry standards and regulations. Fire-resistant cables are designed to maintain their functionality and structural integrity during a fire, so testing their performance under fire conditions is critical. Fire-resistant cables are typically tested and certified according to specific industry standards (e.g., IEC 60331, BS 6387), indicating the duration for which they can withstand fire conditions while maintaining their functionality.

Select a Testing Facility: To properly test fire-resistant cables, one should work with a certified testing laboratory or facility that specializes in fire resistance testing. These facilities have the necessary equipment and expertise to conduct accurate and controlled tests.

Prepare the Test Setup: Ensure that the test area and equipment are in compliance with safety standards to minimize risks. Set up the cables to be tested according to the specific test standard or certification requirements. This may involve securing the cables in a vertical or horizontal configuration, as specified by the standard.

Simulate Fire Conditions: Create a controlled fire environment in a testing chamber or furnace. The temperature, duration, and other conditions should align with the relevant testing standards, such as IS 17505, IEC 60331 or BS 6387. Monitor and record the temperature and other parameters within the chamber to ensure accuracy.

Apply Load and Electrical Testing: During the fire test, maintain electrical load on the cables to simulate real-world conditions. This load should be representative of the cables' intended use. Continuously monitor the cables' electrical performance throughout the test. Measure factors like electrical continuity, insulation resistance, and voltage resistance to ensure they meet the standards.

Assess Structural Integrity: Evaluate the cables' physical integrity during the test. This includes checking for any signs of deformation, cracking, or damage to the cable's insulation, sheathing, or conductors. Measure the cable's diameter and ensure it remains within acceptable limits.

Duration of Test: The duration of the fire test should conform to the relevant standard. Different standards specify different fire exposure times. For example, some standards require cables to withstand fire for 30 minutes, while others may demand longer durations.

Smoke and Toxic Gas Emissions: Monitor and record smoke and toxic gas emissions, if required by the testing standard. Some standards include limits on the amount of smoke and toxic gases produced during the test.

Recording Data: Document all relevant data and observations during the test, including temperature profiles, electrical measurements, and any visible damage or changes to the cable.

Post-Test Evaluation: After the test is complete, carefully inspect the cables for any damage or changes in performance. Compare the results to the requirements of the specific standard or certification criteria.

Certification: If the cables meet the criteria specified in the standard, they can be certified as fire-resistant cables. Certification is typically provided by accredited testing bodies, and the cables can then be labelled accordingly.

It is important to note that fire-resistant cable testing should be performed in accordance with the specific standard or regulation that applies to the intended use of the cables. Different standards may have varying requirements for temperature, duration, load, and other factors, so it's crucial to follow the appropriate guidelines to ensure compliance and safety. Additionally, working with experienced consultants, professionals and accredited testing facilities is essential to obtain accurate and reliable results.

Special Tests to be carried out on Fire-resistant cables

Fire-resistant cables undergo a series of special tests to ensure their performance under fire conditions and compliance with industry standards and regulations. These tests assess various aspects of the cables' behaviour during fire condition. Apart from the standard tests for power cables, some of the key tests carried out on fire-resistant cables are listed below:

1. Fire Endurance Test:

   This test evaluates the cable's ability to withstand exposure to fire at a specified temperature for a defined duration. The cable is subjected to a controlled fire in a furnace, and its ability to maintain electrical functionality is assessed.

2. Electrical Continuity Test:

   During the fire endurance test, the electrical continuity of the cable is continuously monitored to ensure it remains intact. The cable must maintain electrical connectivity even in the presence of high temperatures and flames.

3. Insulation Integrity Test:

   This test assesses the integrity of the cable's insulation materials during a fire. It measures factors such as insulation resistance and dielectric strength to ensure that the insulation remains effective.

4. Mechanical Shock Test:

   After exposure to fire, the cable may be subjected to a mechanical shock to evaluate its structural integrity. This test checks if the cable can withstand physical stress and mechanical damage after a fire.

5. Water Spray Test:

   Some fire-resistant cable standards require a water spray test to simulate the effects of firefighting efforts. The cable is exposed to a water spray to assess its performance when exposed to water during a fire.

6. Smoke Emission Test:

   This test measures the amount of smoke produced by the cable during a fire.

   Limits on smoke emission are often specified in standards to ensure visibility and safety during evacuations.

7. Toxic Gas Emission Test:

   In some cases, the cable's emissions of toxic gases, such as hydrogen chloride (HCl), hydrogen fluoride (HF), and others, are measured during a fire. Standards may include limits on toxic gas emissions to protect occupants.

8. Flame Spread Test:

   Flame spread tests assess the cable's ability to resist the spread of flames along its length. The cable is exposed to flames, and its flame spread characteristics are observed.

9. Burning Behaviour Test:

   This test examines how the cable behaves when subjected to fire, including factors like dripping and self-extinguishing behaviour. Dripping cables can pose additional fire hazards.

10. Impact Test:

    The cable may be subjected to an impact test to assess its resistance to mechanical damage, such as falling debris during a fire condition.

11. Corrosivity Test:

    Some standards require a test to evaluate the corrosive effects of combustion gases on materials in contact with the cable.

12. Cable Diameter Measurement:

After the fire test, the cable's diameter is checked to ensure it remains within acceptable limits.

It is important to note that the specific tests and their parameters may vary depending on the applicable standards and regulations in different regions. Consultants and specifiers shall correctly identify the application and the testing requirements as some tests may call for additional costs. Fire-resistant cable manufacturers must follow the relevant standards to ensure the cables meet safety and performance requirements. Certifications from accredited testing bodies are often used to verify compliance with these standards.

Conclusion

In summary, the key distinction between fire-resistant and fire-retardant cables lies in their primary purpose and function during a fire condition. Fire-resistant cables are meant to maintain electrical functionality, while fire-retardant cables are designed to slow down the spread of fire but do not ensure continued operation of electrical circuits. The choice between these two types of cables depends on the specific fire safety requirements and regulations applicable to the installation and the criticality of electrical systems. It is important to check compliance of the CFOs requirements as well as international best practices while selecting and specifying the Fire-Resistant and Fire-Retardant cables.

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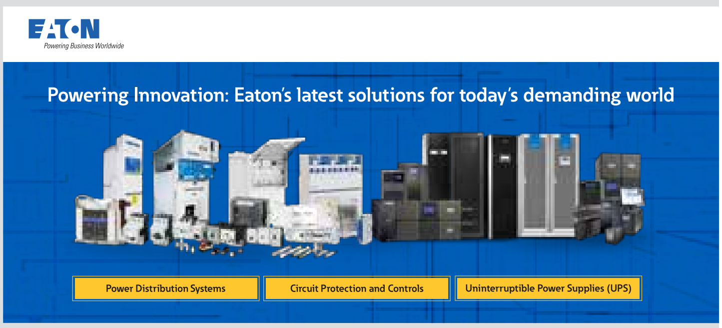

CEEAMA pays tribute to scientists born in October
Dr. APJ Abdul Kalam & Dr. Homi Bhabha

Dr. APJ Abdul Kalam

Born on October 30, 1909 in Bombay, Homi Jehangir Bhabha played an important role in the Quantum Theory. He was the first person to become the Chairman of the Atomic Energy Commission of India. Having started his scientific career in nuclear physics from Great Britain, Bhabha returned to India and played a key role in convincing the Government to start the ambitious nuclear programme. Pursuant to the Atomic Energy Act, the Atomic Energy Commission (AEC) was established on 10 August 1948. Nehru appointed Bhabha as the Commission's first chairman.

Bhabha is considered the "father of the Indian nuclear programme" and one of the most prominent scientists in the country's history. After his death, the Atomic Energy Establishment at Mumbai was renamed the Bhabha Atomic Research Centre (BARC) in his honour.

Bhabha's doctoral thesis won him the Adams Prize in 1942, making him the first Indian to receive the honour. This was followed by a Hopkins Prize by the Cambridge Philosophical Society in 1948. He was awarded the Padma Bhushan, India's third-highest civilian honour, in 1954.

Dr. Homi J Bhabha

Avul Pakir Jainulabdeen Abdul Kalam, born on October 15, 1931 is an Indian scientist who worked as an Aerospace engineer with Defence Research and Development Organisation (DRDO) and Indian Space Research Organisation (ISRO).

Kalam started his career by designing a small helicopter for the Indian Army. Kalam was also part of the INCOSPAR committee working under Vikram Sarabhai, the renowned space scientist. In 1969, Kalam was transferred to the Indian Space Research Organization (ISRO) where he was the project director of India's first indigenous Satellite Launch Vehicle (SLV-III) which successfully deployed the Rohini satellite in near earth's orbit in July 1980.

He also served as the 11th President of India from 2002 to 2007. Kalam advocated plans to develop India into a developed nation by 2020 in his book India 2020. He has received several prestigious awards, including the Bharat Ratna, India's highest civilian honour.

Long distance cabling: Challenges in installing Power and Fiber Optic cables

Bharat has been actively involved in the development and deployment of long distance power and fiber optic cabling involving treacherous mountains, undersea power cables, particularly for offshore renewable energy projects and cross-border electricity transmission. Undersea power cables are used to establish these interconnections, enabling the exchange of electricity and promoting regional energy cooperation. The country has been working on cross-border electricity transmission projects with neighbouring countries like Bangladesh, Sri Lanka, and Nepal. There have been discussions about importing hydropower from Bhutan using long distance cabling.

In addition to offshore wind, the country has been exploring other forms of marine renewable energy, such as tidal and wave energy. These technologies may require undersea cable connections to transport generated electricity to the mainland. Bharat has been exploring the possibility of exporting excess renewable energy, primarily solar and wind power, to neighbouring countries. Undersea power cables could facilitate the transmission of clean energy to energy-deficient regions.

This article aims at providing some insight in long distance cabling. Since the onshore cabling is known to most of us, the article focuses on under-sea cabling and the issues therein.

Challenges in Long distance cabling

Long distance cabling and undersea cabling (including submarine power cables and submarine fiber optic cables) face various challenges and problems due to the harsh marine environment and the technical complexity of these installations.

1. Cost: The cost of long-distance cabling is traditionally very high, about 5 to 6 times that of the overhead transmission. This is a major challenge especially in developing and poor nations. Due to this reason, there is a major thrust on undersea cabling where there is no other option for transmitting power available.
2. Fault Location: Locating the exact location of a cable fault or break in the vast expanse of the terrain or seabed can be a challenging and time-consuming process, delaying repair efforts.
3. Environmental Impact: The installation and maintenance of long-distance terrain or undersea cables can have environmental impacts, including disturbance to flora, fauna, marine ecosystems and habitats.
4. Natural Hazards: Long distance cables and undersea cables are vulnerable to natural disasters such as earthquakes, landslides, tsunamis etc. These events can cause cable breaks or damage. These are applicable for overhead transmission lines also, in which case re-instating the lines can be less expensive than in cabled networks.
5. Equipment handling: Long distance power cabling can often result in larger cross sections or multiple runs of cables which could be very tough from handling perspective. The larger cross section is required due to voltage drop considerations, Ferranti effect issues etc.
6. Complex Repairs: Repairing damaged cables requires specialized equipment and expertise. Depending on the location and depth of the cable, repairs can be logistically complex and costly.
7. Regulatory Challenges: Dealing with multiple jurisdictions and regulatory bodies on land as well as in international waters can create challenges in terms of permitting, coordination, and compliance.
8. Marine Wildlife: Marine animals like sharks are known to be attracted to the electromagnetic fields generated by submarine cables. They can bite or damage cables, leading to disruptions.
9. Corrosion: The marine environment is highly corrosive, and over time, it can corrode the protective layers of submarine cables, potentially causing insulation breakdown or other issues.
10. Cable Markers issue: In some regions, there have been instances of cable theft for the valuable materials

within the cables, leading to service interruptions. While cable markers are good to identify routes, these are actually detrimental in long distance cabling on land as it helps easy identification of the route, aiding theft. The exact opposite condition exists in under sea cabling where cable markers cannot be laid, leading to accidents due to entanglement or anchor dragging.

11. Physical Damage: Sub-sea cables can be damaged by a variety of factors, including fishing trawlers, anchor dragging, and ship anchors. These physical impacts can lead to cable cuts, exposing the cable's core and disrupting communication or power transmission. Large ships and vessels can accidentally drag their anchors across the seabed, entangling and damaging undersea cables. Anchor-related incidents are a common cause of cable damage in undersea cabling.

12. Depth and Pressure: Submarine cables are often laid at significant depths, subjecting them to high water pressure, which can impact cable integrity and longevity.

13. Competing Interests: There may be competing interests in the use of the seabed where cables are laid, such as fishing, shipping, and offshore energy development. These interests can lead to conflicts and potential cable damage.

14. Disruptions: Damage to submarine power cables can interrupt the supply of electricity between regions or countries, affecting energy security and reliability. Damage to submarine fiber optic cables can disrupt international telecommunications, causing significant economic and communication issues.

To mitigate these problems, long distance cabling contractors and undersea cable operators employ various strategies, including using armoured cables to protect against physical damage, conducting regular inspections, implementing strict route planning and maintenance protocols and employing marine monitoring systems where applicable. Additionally, international cooperation and agreements are often necessary to address issues related to undersea cable protection, repair, and security.

Cable Joints

It is important to note that the use of joints or splices in long-distance cabling can introduce potential points of failure or signal loss, for power and fiber optic cables respectively, if not properly designed, installed, and maintained. Proper techniques, materials, and testing are essential to ensure the reliability and performance of the cabling system when joints are used. In some critical applications, minimizing the number of joints may be preferred to maintain signal integrity and reliability.

There are various reasons why joints are inevitable. Long-distance cables are often manufactured in specific lengths due to manufacturing constraints or transportation limitations. These cables may need to be connected together to cover the required distance. Joints allow for the connection of multiple cable segments, effectively extending the cable's length. Joints enable the customization of cable lengths to meet specific project requirements. This can be particularly important in situations where precise measurements are needed, such as in telecommunications or networking installations. In some cases, it is more practical to install shorter cable segments and then join them

together rather than trying to handle and install a single very long cable. This approach can make installation easier and more manageable. Pulling a very long cable through conduit or trenches can subject the cable to excessive stress and tension, increasing the risk of damage. By using joints and connectors, cable sections can be safely pulled through these spaces and then connected together. Over a period of time, cables can degrade or suffer damage from various environmental factors, including moisture, temperature fluctuations, physical wear, or accidental damage. When a section of the cable is damaged or needs maintenance, joints allow for the replacement of that specific section without replacing the entire cable.

Joints also allow for future expansion or modification of the cable infrastructure. If additional connections or segments are needed at a later time, new cable segments can be added and joined to the existing infrastructure.

When a cable fault occurs in a long-distance cable run, it can be challenging to identify the exact location of the problem. Joints provide convenient access points for testing and troubleshooting. Technicians can isolate and identify the fault more easily by testing each cable segment individually.

Integrity of Cable Joints

It's important to note that the design and construction of joints in long distance cabling and especially in undersea cabling are highly specialized and require careful engineering to ensure the long-term reliability of the cable system. The materials used must be corrosion-resistant, and the joints must be able to withstand the high pressures and challenging conditions found in the depths of the ocean. Additionally, maintenance and repair of undersea cables can be complex and require specialized equipment and expertise due to the remote and underwater nature of the infrastructure.

While the issues pertaining to cable joints in onshore projects are well-known the article focuses on joints in under-sea fiber optic cabling as a special application in the next section.

Joints in under-sea fiber optic cabling

Joints in undersea cabling, such as submarine fiber optic cables, are points where two sections of cable are connected together. These joints, also known as splices or repeater housings, are crucial components in undersea cable systems.

Longer lengths necessitate higher number of drums and hence jointing is inevitable. Submarine cables are often laid in multiple sections, and these sections need to be connected during the initial installation. Joints are used to link these sections together, allowing for the continuous transmission of data across the entire cable system.

Sub-sea joints must maintain the signal's integrity as it passes through the connection point. High-quality splicing techniques and materials are used to minimize signal loss or degradation at the joint. The joints are typically designed with security measures to prevent tampering or unauthorized access. Protecting undersea cables from sabotage or theft is critical for national and international communication networks.

Some undersea cable systems include repeaters at regular intervals to boost the signal as it travels long distances. These repeaters are often housed within specialized joint sections. The joints not only protect the repeaters but also provide the electrical and optical connections needed to power and amplify the signal.

In more complex undersea cable systems, branching units or junctions are used to split the cable into multiple branches, allowing connections to different landing stations or branching off to serve different regions. These branching units are types of joints that enable the network to be expanded or configured in various ways.

Undersea cables operate in a challenging environment characterized by high water pressure, temperature variations, and exposure to marine life. Joints are designed to provide a sealed and protective enclosure that safeguards the cable's internal components from these environmental factors.

One of the primary purposes of joints in undersea cabling is to facilitate cable repair and maintenance. Over time, undersea cables can be damaged by various factors, including anchor strikes, fishing activities, natural disasters, or environmental wear and tear. When a cable is damaged, the damaged section can be cut and replaced with a new cable segment, and this replacement is made possible by joints.

Some joints may include monitoring equipment to allow for remote monitoring of the cable's health and performance. They may also provide access points for maintenance and repairs, enabling technicians to connect to the cable system.

Bharat's initiatives leading to long distance cabling projects

Bharat has been working on several interconnection projects with neighbouring countries to facilitate cross-border electricity trade involving long distance cabling. Undersea power cables play a pivotal role in some of these projects. For instance, the Bharat-Sri Lanka interconnection project (500MW) aims to link the power grids of both countries through undersea cables. The country has been investing in submarine cable infrastructure to support its growing demand for high-speed internet connectivity and communication. While these cables primarily serve data transmission purposes, they also have the potential to carry power in the event of future requirements for power exchange between regions.

The country has been exploring the potential of offshore wind energy to diversify its renewable energy portfolio. The development of offshore wind farms requires the installation of undersea power cables to connect the turbines to onshore grids. Various projects and feasibility studies have been initiated to harness the vast offshore wind energy resources. We hope the article provides basic information on the challenges involved in long distance cabling, especially under-sea cabling.

Acknowledgement:

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2. "Fiber Optic Communications" by Joseph C. Palais.
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Contributor

Chidambar V. Joshi

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Power over Ethernet (POE) cables – Basic Principles

Power over Ethernet (PoE) is a technology that allows both data and electrical power to be transmitted over Ethernet cables, eliminating the need for separate wiring for each purpose. In doing so, this reduces installation costs and improves flexibility by eliminating redundant cabling. It is commonly used to power devices like IP cameras, VoIP phones, wireless access points, and other networked devices, eliminating the need for separate power cables and outlets for these devices. PoE is particularly useful in situations where it may be difficult or expensive to provide dedicated power sources.

There are many industries that have successfully adopted the use of PoE, for example surveillance cameras, air conditioning systems, telephones and supermarket checkouts. PoE has improved efficiency and created opportunity however without the correct structured cabling infrastructure in place it can experience multiple issues such as overheating or connection issues affecting the integrity of the data for the end user.

Construction of PoE cables:

PoE cables generally have four cores (four pairs of wires). There are mainly two pairs of cores in PoE cables. Two cores are used for data transmission (Ethernet), and the other two cores are used for power transmission, enabling both data and electrical power to be carried over a single cable to PoE-enabled devices. The number of conductors within each core is typically two, allowing for the transmission of power and ground within each pair.

<u>Data Cores (Ethernet):</u> Two of the twisted pairs (four wires) are used for data transmission and reception. These are typically used for standard Ethernet communication, including sending and receiving data packets between devices on the network.

<u>Power Cores (DC Power):</u> The other two twisted pairs (four wires) are used for power transmission. One pair is used for the positive (+) power supply, and the other pair is used for the negative (-) or return path of the DC power.

Components used in implementing Power over Ethernet:

To implement PoE, the following components are required:

- PoE Switch or Injector: A PoE-capable network switch or PoE injector is required. The switch supplies power to connected devices through the Ethernet cables. PoE injectors can be used to add PoE capabilities to non-PoE switches.
- Power Sourcing Equipment (PSE): This is the equipment that provides power over the Ethernet cable. It can be either a PoE-capable switch or a PoE injector.
- Powered Device (PD): The PD is the device that receives both data and power over the Ethernet cable. It typically has a PoE-compatible network interface, which includes special circuitry to separate and use the power provided by the PSE. The device to power, such as an IP camera or VoIP phone, needs to support PoE. It has a PoE-compatible network interface.
- Power Delivery: When the PSE detects a PoE-compatible device connected to one of its Ethernet ports, it negotiates with the device to determine how much power it needs. This negotiation process follows the IEEE 802.3af (PoE) or IEEE 802.3at (PoE+) standard.
- Data and Power Transmission media: Once the power requirements are established, the PSE delivers both data and electrical power over the same Ethernet cable to the PD. The power is typically delivered using one of the unused pairs of wires in the Ethernet cable, so it doesn't interfere with data transmission.
- PD Power Conversion: The PD receives the power and converts it into the appropriate voltage and current levels needed to operate the device. It may also include circuitry for power management and protection.

- End Device Operation: The powered device operates as if it were connected to a traditional power source. It can transmit and receive data while being powered through the Ethernet cable.

History of PoE

Power over Ethernet (PoE) technology was first introduced in the early 2000s. The IEEE 802.3af standard, which defined the initial specifications for PoE, was ratified in June 2003. This standard allowed for the delivery of up to 15.4 watts of electrical power over Ethernet cables to power devices like IP phones and security cameras.

Since then, PoE technology has continued to evolve, with the introduction of higher-power standards such as IEEE 802.3at (PoE+), which can deliver up to 30 watts of power per port, and IEEE 802.3bt (4PPoE), which can provide even higher power levels, up to 100 watts per port. These higher-power standards have expanded the range of devices that can be powered over Ethernet and have made PoE more versatile in various applications.

Limitations of Power over Ethernet cables

Power over Ethernet (PoE) is a versatile technology that offers significant advantages, but it also has some limitations the designer should be aware of when planning and implementing PoE solutions:

1. The most significant limitation of PoE is its power capacity. The power delivered to powered devices (PDs) is limited by the PoE standard being used. The most common standards are IEEE 802.3af (PoE) and IEEE 802.3at (PoE+), which provide up to 15.4 watts and 30 watts of power per port, respectively. While this is sufficient for many devices like IP phones and security cameras, it may not be enough for power-hungry devices or those with high-performance requirements.
2. The power that can be delivered over Ethernet cables diminishes with cable length. Longer cables introduce more resistance, which can lead to voltage drop. This means that in case of long cable runs, the available power at the PD may not be sufficient. Using higher-gauge Ethernet cables can mitigate this issue to some extent. The maximum cable length for Ethernet connections, including PoE, is typically 100 meters (328 feet). Beyond this distance, one may experience signal degradation and power delivery issues.
3. Not all devices support PoE, so the designer needs to ensure that the network equipment, including switches and powered devices, are PoE-compatible.
4. PoE-capable network switches are generally expensive than non-PoE switches. The added cost can be a limitation for small-scale deployments or when upgrading existing network infrastructure to support PoE.
5. PoE switches have a limited power budget, which dictates how much power can be distributed across all connected powered devices simultaneously. If the power budget is exceeded, some devices may not receive enough power, or the switch may shut down power to certain ports. Managing the power budget effectively is essential in larger PoE deployments. While standards like PoE+ and PoE++ (802.3bt) provide higher power levels, there are limitations in terms of the number of devices that can be powered simultaneously at these higher power levels. High-power PoE is typically used for specific applications like lighting and high-end pan-tilt-zoom cameras.
6. Some devices may require specific voltage levels that are not provided by standard PoE. In such cases, additional power converters or adapters may be needed, adding complexity and cost to the deployment.
7. PoE can transmit electrical power over Ethernet cables, which could pose safety risks if not properly managed. It's important to follow safety guidelines and ensure that cables and equipment meet safety standards.
8. PoE devices can generate heat, especially when delivering high levels of power. Proper ventilation and cooling may be necessary to prevent overheating, particularly in confined spaces or equipment cabinets.

Despite these limitations, PoE remains a valuable technology for simplifying the deployment and management of networked devices, especially in scenarios where running separate power cables would be impractical or costly. It is essential to carefully assess the specific requirements and limitations before implementing a PoE solution to ensure it meets the needs effectively and safely.

Testing of PoE cables

Laboratory testing of PoE cables is crucial to ensure that they meet the necessary standards and perform reliably in real-world applications. The testing of PoE cables essentially covers the following thought process:

- Transmission testing – to ensure the cable meets the industry standards for signal performance
- Temperature control – to avoid overheating and data transfer failing
- Performance futureproofing – to ensure the network is built to accommodate growth advancements, such as higher power requirements or further increases in the number of cables within a bundle

Some common tests and procedures conducted in a laboratory setting for PoE cables:

1. Insulation Resistance Testing

   This test checks the insulation between the cable conductors to ensure it meets safety standards and won't result in short circuits or electrical hazards.

2. Continuity Testing

   This test ensures that each conductor in the cable is connected correctly from one end to the other without any breaks or shorts. Proper continuity is essential for both data and power transmission.

3. Resistance Testing

   This test measures the resistance of the cable conductors to ensure they meet the specified values. Lower resistance values indicate better power transmission efficiency and less voltage drop over the cable's length.

4. Impedance Testing

   PoE cables should have a consistent impedance along their length to minimize signal reflections and maintain data transmission quality. Laboratory tests measure impedance at various points along the cable.

5. Voltage Drop Testing

   PoE cables must maintain a certain voltage level at the powered device (PD) end, even when delivering power over long cable runs. Laboratory tests assess voltage drop to ensure it remains within acceptable limits for the given cable length and power level.

6. Cross-Talk Testing

   This test assesses the level of electromagnetic interference (EMI) and cross-talk between cable pairs. Low cross-talk is essential for maintaining signal integrity in PoE applications.

7. EMI/RFI Shielding Effectiveness Testing

   PoE cables may have shielding to protect against external electromagnetic interference (EMI) and radio frequency interference (RFI). Lab tests measure the effectiveness of this shielding.

8. Cable Bend and Flex Testing

   Cables must endure bending and flexing without damage or signal loss. Lab tests may subject the cable to repeated bending and flexing to evaluate its durability.

9. Heat and Flame Resistance Testing

   PoE cables should be able to withstand elevated temperatures and resist flames to ensure safety in case of a fire. Flame and heat resistance tests evaluate the cable's performance under such conditions.

10. Cable Length Verification

Lab tests can verify that the cable length matches the specified length, as inaccuracies can affect power delivery and signal quality.

11. Environmental Testing

Cables may undergo environmental tests to assess their performance under various conditions, including extreme temperatures, humidity, and exposure to chemicals.

12. Safety Compliance Testing

PoE cables must meet safety standards to prevent electrical hazards. Testing includes assessments of insulation, grounding, and other safety-related factors.

13. Connector Testing

Connectors are a critical part of PoE cables. Laboratory tests may include insertion and withdrawal testing to ensure connectors maintain a reliable connection over time.

14. Dynamic Load Testing

Dynamic load testing determines how well PoE cables handle sudden changes in load or power demand, simulating real-life scenarios where devices are powered on or off. Measurements are taken for voltage and current limits.

15. Protocol Testing

For cables used in data transmission applications, protocol testing ensures that the cables meet data transmission standards, such as Ethernet or any other communication protocols.

Examples of PoE applications (apart from CCTV)

1. Smart lighting systems, powered by PoE, which deliver multiple applications via one cabling system such as motion sensor technologies are proving to be far more efficient.
2. Air-conditioning systems are automated, driven by IoT technologies, using PoE which allows greater flexibility at installation and remote-control enabling monitoring that reaches all areas of the building.
3. Central control units, which link air-conditioning technology and other smart applications such as temperature control gauges, typically found within data centers are crucial to preventing the risk of overheating and associated failures. PoE technology allows for both power and temperature data to be transmitted over one cabling structure.
4. Fire alarm systems and emergency lighting systems
5. In process automation sensor technologies typically found in warehouse conveyer belt systems and similar applications which is often seen to be a new invention, PoE has enabled for both data and power to feed to and from the device for a seamlessly consistent, repeatable processes.

Conclusion:

Today's networks must be fast and reliable, with the flexibility to handle ever-increasing data demands. PoE technology can help expand network possibilities enabling business flexibility by improving processes and staying competitive. PoE, however, is only effective when installed correctly and to the highest standard. Proper design and specifications coupled with competent contractors and high-quality testing can help ensure the longevity of PoE cables for a dependable service.

Acknowledgement:

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4. "Power Over Ethernet for Industrial Applications" by Klaus Weiß, Rüdiger H. Stroh, and Thomas Jell
5. "Data Center Handbook" by Hwaiyu Geng
6. "Ethernet: The Definitive Guide" by Charles E. Spurgeon
7. "Structured Cabling System Design and Installation" by Richard B. Parish
8. "Network Design Cookbook: Architecting Cisco Networks" by Ciscopress
9. Google and Wikipedia references

Contributor

Chidambar V. Joshi

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The concept of "Chartered Electrical Safety Engineer", was first introduced under the Central Electricity Authority (Measures relating to Safety and Electric Supply) Amendment Regulations 2015, under Regulation 5A, for the purpose of self-certification by a supplier, or Owner or consumer of his electrical installation, having voltage equal to or below the notified voltage by the Appropriate Government.

As per the Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulations 2023, (Latest Regulations) "Chartered Electrical Safety Engineer" means a person authorised by the Appropriate Government as referred in regulation 6;

Regulation 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, which are described below.

[Note: "**self-certification**" means a certification by a supplier or owner or consumer in the prescribed format as required under regulation 32 and regulation 45]

(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.

Regulation 32, **Periodic inspection and testing of installations**. – (1) The periodic inspection and testing of installation of voltage above the notified voltage belonging to the owner or supplier or consumer, as the case may be, shall be carried out by the Electrical Inspector:

Provided that the electrical installation below or equal to the notified voltage shall be self-certified by the owner or supplier or consumer, as the case may be.

(2) The periodicity of electrical inspection by the Electrical Inspector or the self-certification by the supplier, owner or consumer shall be as directed by the Appropriate Government:

Provided that the periodicity of electrical inspection and self-certification shall not exceed five years:

Provided further that in respect of the electrical installation belonging to mines, oil-fields and railways,

such direction shall be issued by the Central Government.

(3) The periodic inspection and testing of installation of voltage equal to or below the notified voltage belonging to the owner or supplier or consumer, as the case may be, shall be carried out by the owner or supplier or consumer and shall be self-certified for ensuring observance of safety measures specified under these regulations and the owner or supplier or consumer, as the case may be, shall submit the report of self-certification to the Electrical Inspector in the Form I or Form II or Form III or Form IV, as the case may be, of Schedule II:

Provided that the electrical installation so self-certified shall be considered as duly inspected and tested only after the report of self-certification is duly received by the office of Electrical Inspector and if not acknowledged by the Electrical Inspector within three working days, it shall be deemed to be received:

Provided further that the owner or supplier or consumer has the option to get his installation inspected and tested by the Electrical Inspector of the Appropriate Government.

(4) Notwithstanding anything contained in sub-regulation (3), every electrical installation covered under section 54 of the Act including every electrical installation of mines, oil-fields and railways shall be periodically inspected and

tested by the Electrical Inspector of the Appropriate Government.

(5) Where the supplier is directed by the Central Government or the State Government, as the case may be, to inspect and test the installation, such supplier shall report on the condition of the installation to the consumer concerned in the Form I, Form II, Form III and Form IV as provided in Schedule II and shall submit a copy of such report to the Electrical Inspector.

(6) The Electrical Inspector may, on receipt of such report, accept the report submitted by the supplier or record variations as the circumstances of each case may require and may recommend that the defects may be rectified as per report.

(7) In the event of the failure of the owner of any installation to rectify the defects in his installation pointed out by the Electrical Inspector in his report and within the time indicated therein, such installation shall be liable to be disconnected under the directions of the Electrical Inspector after serving the owner of such installation with a notice for a period not less than forty eight hours:

Provided that the installation shall not be disconnected in case an appeal is made under sub section (2) of section 162 of the Act and appellate authority has stayed the orders of disconnection.

(8) It shall be the responsibility of the owner of all installations to maintain and operate the installations in a condition free from danger and as recommended by the manufacturer or by the relevant standards.

Regulation 45, Approval by the Electrical Inspector and self-certification. – (1) (a) Every electrical installation of notified voltage and below shall be inspected, tested and self-certified by the owner or supplier or consumer, as the case may be, of the installation before commencement of supply or recommencement after shutdown for six months or more for ensuring observance of safety measures specified under these regulations and such owner or supplier or consumer, as the case may be, shall submit the report of self-certification to the Electrical Inspector in the forms as provided under Schedule II of these regulations:

Provided that the self-certified electrical installation shall be considered fit for the commencement of supply or recommencement after shutdown for six months only after the report of self-certification is duly received by the office of Electrical Inspector and if not acknowledged by the Electrical Inspector within three working days, it shall be deemed to be received:

Provided further that the owner or supplier or consumer, as the case may be, has the option to get his installation inspected and tested by the Electrical Inspector of the Appropriate Government;

(b) Notwithstanding anything contained in clause (a), every electrical installation covered under section 54 of the Act including every electrical installation of railways shall be inspected and tested by the Electrical Inspector of the Appropriate Government as specified in sub-regulation (3).

(2) The voltage above which inspection and testing of electrical installations including installations of supplier or consumer to be carried out by the Electrical Inspector, shall be notified by the Appropriate Government;

(3) Every electrical installation of voltage above the notified voltage and all the apparatus of the generating units above the capacity specified under regulation 34, shall be inspected and tested by the Electrical Inspector before commencement of supply or recommencement after shutdown for six months or more for ensuring observance of safety measures specified under these regulations.

(4) Before making an application to the Electrical Inspector for permission to commence or recommence supply in installations above the notified voltage after an installation has been disconnected for six months or more, the supplier shall ensure that electric supply lines or apparatus of more than notified voltage belonging to him are placed in position, properly joined, and duly completed and examined, and the supply of electricity shall not be commenced by the supplier for installations of voltage needing inspection under these regulations unless the provisions of regulations 14 to 31, regulations 35 to 37, regulations 46 to 53 and regulations 57 to 80 have been complied with and the approval in writing of the Electrical Inspector has been obtained by him:

Provided that the supplier may energise the aforesaid electric supply lines or apparatus for the purpose of tests specified in regulation 48.

(5) The owner of any installations of voltage above the notified voltage shall, before making application to the Electrical Inspector for approval of his installation or additions thereto, test every circuit or additions thereto, other than an overhead line, and satisfy himself that they withstand the application of the testing voltage set out in regulation 48 and shall duly record the results of such tests and submit them to the Electrical Inspector:

Provided that the Electrical Inspector may direct such owner to carry out such tests, as he deems necessary or accept the certified tests of the manufacturer in respect of any particular apparatus in place of the tests required by this regulation.

(6) The owner of any installation who makes any addition or alteration to his installation shall not connect to the supply his apparatus or electric supply lines, comprising the said alterations or additions, unless and until such alteration or addition has been approved in writing by the Electrical Inspector or self-certified by the owner of the installation, as the case may be.

(7) In case of installations of mines and oil-fields, the electrical installations of voltage 650 V and above shall not be connected to supply, unless and until such installation work including alterations or additions or recommencement after shutdown for six months are approved in writing by the Electrical Inspector of Mines:

Provided that the electrical installations of voltage below 650 V in mines and oil-fields are to be self- certified by the owner or agent or manager of the mine before commencement of supply or recommencement after shutdown for six months or more in the manner specified in sub-regulation (1).

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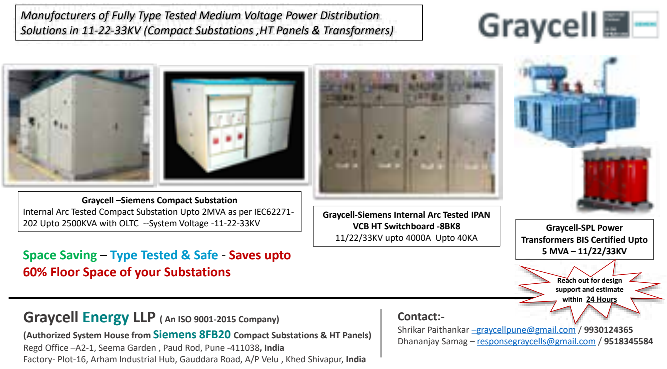

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QUIZ OCTOBER 2023

1. A dual-element fuse is used to:
    a) Operate at a higher voltage
    b) Operate at a higher current
    c) Operate with a temporary overload
    d) Protect the transistor.

2. Visvesvaraya was appointed a Companion of the Order of the Indian Empire (CIE) in 1911 by:
    a) King Edward VII
    b) Lord Mountbatten
    c) Pandit Jawaharlal Nehru
    d) Duke of Windsor

3. If a fuse blows when the start button is pressed, what should you check for?
    a) Shorted motor circuit
    b) Open coils
    c) Grounded fuse holder
    d) Open neutral

4. The owner hired an electrician to prepare and install the electrical wiring for his house. The electrician with the owner's consent, decided to use a larger size of wiring for the circuit breaker to anticipate overload. After some time, the house was on fire. After the investigation, it has proven that the cause of the fire was faulty wiring. Why did the circuit breaker fail to detect the short circuit/ overloading?
    a) The circuit breaker is defective
    b) The capacity of the wire is too large
    c) The circuit breaker was too far away from where the short circuit happened
    d) All of the above

5. This equipment uses a stream of compressed air directed downwards to form a shield to exclude drafts?
    a) Air exhaust
    b) Air sweeper
    c) Air curtain
    d) ACU

6. What is the purpose of providing double runs of Cables from Star-Delta starter upto motor?
    a) Provide star point
    b) Divide current approx. by 2
    c) S-D motor has 6 terminals.
    d) All of the above

7. There is a myth prevailing in the field which says:
    a) VFDs save energy
    b) Speed reduction in case of centrifugal machines
    c) VFDs create power quality problems
    d) In class 4 VFDs / Servo drives are used in machine tool applications

8. The purpose of floor cut-outs in a Panel room serves to:
    a) Carry cables from Panel gland plate to Cable trays located on False floor
    b) Carry cables from Panel gland plate to Cable trays located inside cable cellar
    c) Carry cables from Top-entry Panel gland plate
    d) Carry cables from Panel gland plate to Cable trays located inside trench

9. XLPE/SWA/PVC cable:
   a) Inner sheath is Silicon wrapped
   b) XLPE Insulated
   c) Un-armoured cable
   d) Aluminium armoured

10. Examples of cyber-attacks on electrical power networks
   a) Covid-19 bio-warfare (2019-2021)
   b) Koyna Power Station (1968)
   c) Dragonfly/Energetic Bear (2011-2014)
   d) Auckland Ransomware Attack (2021)

Rules for the QUIZ:

- 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
- mentioned on the same.

Please use following google form link to participate in the QUIZ.

https://forms.gle/CqQvX542B2ncJkw26

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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.

September 2023 Quiz Answers

1. B - Balanced power system
2. A – delta-star
3. C - Te α (stator field strength) (rotor field strength)sinδ
4. B - Stochastic control system
5. B - Impedance mismatch
6. A - Decreases
7. B - 6V
8. A - Increase
9. D - All of the above
10. B - Luminous intensity.

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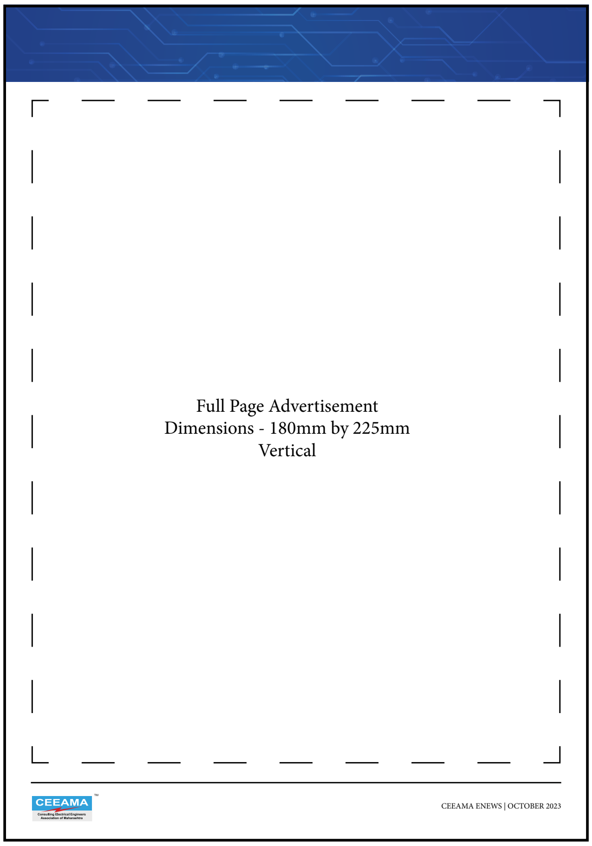

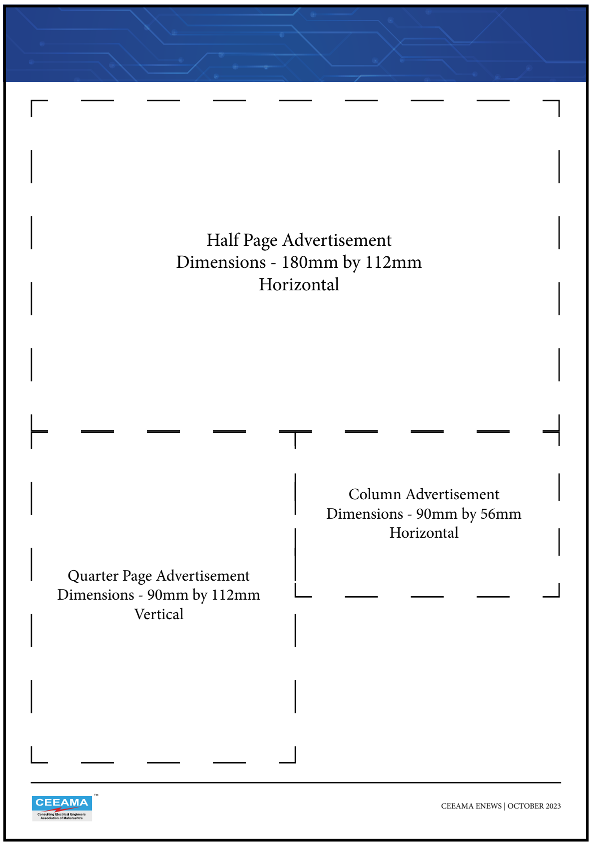

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