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Consulting Electrical Engineers Association of Maharashtra

CEEAMA Live Wire

E-NEWSLETTER

Published by Consulting Electrical Engineers Association of Maharashtra

Topic for March 2025

CATHODIC PROTECTION

Read more about Cathodic Protection Systems inside.

Electrical Consultants Newsletter
Volume No. 4 Issue #48
March 2025

From the Editors Desk,

What a topsy-turvy FY-2024-25 it was! Especially, the stock market bleeding like anything to everyone's despair. India struggles to shake off pessimism after $1.3 trillion stock market rout. Global fund managers remain cautious about Indian stocks despite lower valuations from a prolonged losing streak. Economic slowdown, profit downgrades, and potential US tariffs continue to weigh on the market. Meanwhile, traders are flocking to undervalued Chinese stocks amid a bull run driven by AI developments. Foreign investors have pulled nearly $15 billion from India this year, pushing outflows to surpass last year's record. But despite the drop, the market's multiple remains higher than that of all its emerging Asian peers... and that's something to cheer about!

The month of March celebrates International Women's Day on 8th and reminds us all, especially the male chauvinist society, that the world won't exist without her; maybe without men, it can! Indian history and mythology are full of women power; whether you revere Goddesses Durga, Laxmi, and Saraswati or bow to the heroic struggles of Maharani Tarabai, Rani Laxmibai, and others! Yet, we are far away from achieving the much-touted gender equality!

Wishing our women readers, colleagues, and clients a very happy International Women's day! This is also a big 'shout out' to the mothers, wives, sisters, and family members who pour their heart and energy into creating a safe, nurturing space for their loved ones!

This month we also celebrate Holi, the festival of colour! May this diverse world of diverse people merge into a single colour of truthfulness, care, brotherhood, peace and knowledge with prosperity!

Enjoy this month's issue on the subject of **Cathodic Protection!** Let the life's **"rust" stay away from us** and we always stay industrious and happy!

Subhash L. Bahulekar

Chief Editor – CEEAMA

From the President's desk:

Dear friends,

We now approach the end of the financial year 2025. The Electrical Industry is coming out of the grandest electrical exhibition of the year, ELECRAMA 2025. I had the opportunity to meet and interact with the leading voices of the industry. I also distributed over 150 copies of "Protection Systems" book on behalf of CEEAMA. This exchange sparked many conversations which will change the way we look at the market. The coming decade belongs to India, that is for sure!

In our upcoming March Livewire edition, we explore Cathodic Protection. An often ignored yet very crucial topic, especially in hazardous zones as well as Offshore and Marine Applications. This edition looks to dive deep into applications, standards and regulations around this topic to spread awareness amongst the peers to make installations safer and more robust.

I wish all my friends a bumper closing to the financial year. Let us gear up for a new year with new ideas and renewed enthusiasm.

Warm regards

Mr. Veejhay Limaaye

Hon. President

CEEAMA

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From the Secretary's desk:

Dear Friends,

What a wonderful ELECRAMA 2025!! This was a landmark event in Gurgaon in the last week of February 2025. It surpassed previous editions in scale, innovation, global engagement and positioned it as a catalyst for future developments in the electrical and electronics industry. The event hosted over 1,100 exhibitors, surpassing previous records and attracting more than 400,000 business visitors as per tndindia.com. ELECRAMA 2025 generated an estimated $20 billion in business inquiries, reflecting its unparalleled scale and global appeal as per theprint.in. The event emphasized sustainability, innovation, quality, safety, and reliability, aligning with global trends and the evolving needs of the electrical industry. A standout feature was the launch of the New Energies Pavilion, showcasing breakthrough technologies in battery storage, EV charging infrastructure, digital energy, solar modules, and inverters, highlighting India's rapid strides towards a sustainable and future-ready energy landscape. I was glad that I could meet quite a few CEEAMA Life Members, Patrons as well as Associate Members.

This month we focus on Cathodic Protection in the LiveWire. Cathodic protection (CP) is necessary to prevent corrosion in metal structures that are exposed to harsh environments, such as underground pipelines, ship hulls, offshore platforms, and storage tanks. Corrosion occurs due to electrochemical reactions between metal and its surroundings, leading to material degradation and failure over time. Use of both Sacrificial Anode CP (SACP) and Impressed Current CP (ICCP) technologies are prevalent in the industry. Some tender documents call for both the options to be deployed at the same site for different applications. Sometimes Cathodic Protection (CP) is called a "grey science" because it involves complex electrochemical principles, variable environmental conditions, and unpredictable corrosion behaviour. Unlike straightforward engineering disciplines, CP relies heavily on field experience, trial-and-error adjustments, and periodic measurements. Since CP is a mix of science, engineering, and field expertise, it remains a "grey science" where theoretical knowledge must be combined with practical experience for its successful implementation.

In our endeavour to enhance our technical knowledge, CEEAMA provides a wonderful platform to share experience and hence collective improvement. Sharing experiences among electrical consultants is crucial for professional growth, industry advancement, and ensuring high-quality, safe, and efficient electrical designs. Electrical consulting involves complex problem-solving, compliance with safety codes, and adapting to new technologies. Learning from others ensures compliance with the latest safety, efficiency, and environmental regulations including IS, IEC and NEC standards. Senior consultants can mentor young engineers, ensuring knowledge transfer and industry sustainability. We earnestly request you to write about your experiences in the LiveWire for a wider audience and enrich the society with your knowledge. This will help many to design better, select better material and experience better efficiencies. Do send us your articles for a better reading experience.

Happy Holi to you!!

Mr. Chidambar Joshi

Hon. Secretary

CEEAMA

Cathodic Protection

❖ Introduction:

Corrosion is a natural process that converts a refined metal into a more chemically stable oxide. It is a gradual deterioration of materials (usually metals) by chemical or electrochemical reaction with their environment. An electrochemical reaction is a chemical reaction accompanied by a flow of electrical current.

Most commonly, this means electrochemical oxidation of metal in reaction with an oxidant such as oxygen, hydrogen, or hydroxide. Rusting, the formation of red-orange iron oxides, is a well-known example of electrochemical corrosion. This type of corrosion typically produces oxides or salts of the original metal and results in a distinctive coloration. Corrosion can also occur in materials other than metals, such as ceramics or polymers, although in this context, the term "degradation" is more common. Corrosion degrades the useful properties of materials and structures including mechanical strength, appearance, and permeability to liquids and gases. Corrosive is distinguished from caustic: the former implies mechanical degradation, the latter chemical.

Many structural alloys corrode merely from exposure to moisture in air, but the process can be strongly affected by exposure to certain substances. Corrosion can be concentrated locally to form a pit or crack, or it can extend across a wide area, more or less uniformly corroding the surface. Because corrosion is a diffusion-controlled process, it occurs on exposed surfaces. As a result, methods to reduce the activity of the exposed surface, such as passivation and chromate conversion, can increase a material's corrosion resistance. However, some corrosion mechanisms are less visible and less predictable.

The chemistry of corrosion is complex; it can be considered an electrochemical phenomenon. During corrosion at a particular spot on the surface of an object made of iron, oxidation takes place and that spot behaves as an anode. The electrons released at this anodic spot move through the metal to another spot on the object, and reduce oxygen at that spot in presence of H^+ (which is believed to be available from carbonic acid (H_2CO_3) formed due to dissolution of carbon dioxide from air into water in moist air condition of atmosphere. Hydrogen ion in water may also be available due to dissolution of other acidic oxides from the atmosphere). This spot behaves as a cathode.

The driving force for the corrosion of metals through electrochemical reactions is the free energy of the metal atoms in their metallic form. All chemical systems tend to change so that the free energy present is at a minimum. This is analogous to the flow of water downhill to minimize the free energy due to gravity. Most engineering metals are found in nature in a form with low free energy. These metal ores are chemical compounds consisting of the metal atoms combined with other atoms such as oxygen or sulfur. The process of breaking up these ores into their metallic and non-metallic atoms involves an addition of energy in order to free the metal atoms from the natural, low energy content chemical compounds.

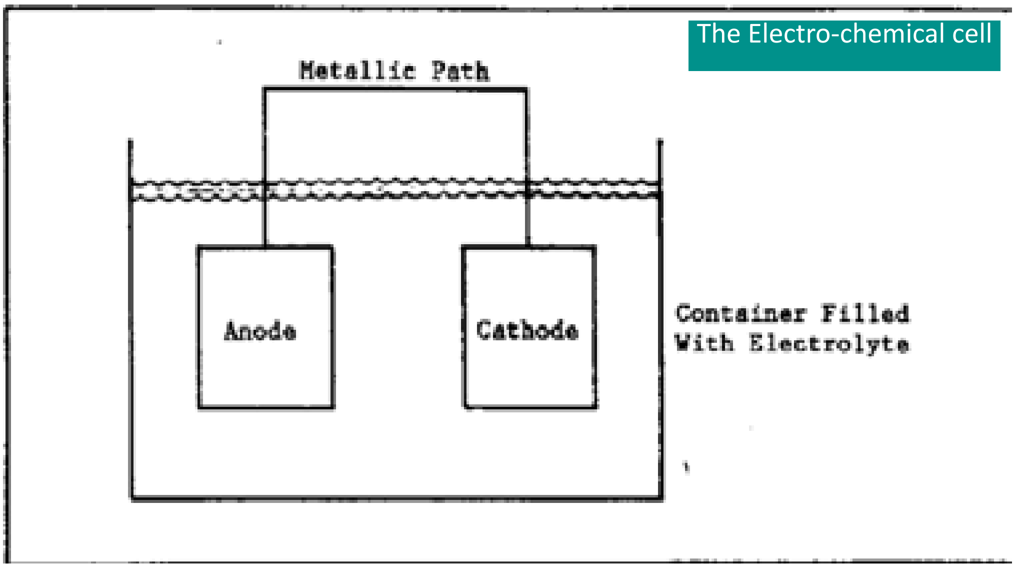
The corrosion process is driven by the tendency of these metal atoms to revert to their natural state. If corrosion products are analyzed, their chemical composition is usually identical to the ore from which the metal was originally obtained.

❖ The Electro-chemical Reaction

Electrochemical reactions occur through a combination of chemical reactions and the exchange of electrical charges (current) between areas where these chemical reactions are occurring. The entire process is commonly known as an electrochemical cell. This process is described in the following paragraphs.

Every electrochemical cell consists of an anode, a cathode, an electrolyte and a metallic path for the flow of electrical current between the anode and cathode. A schematic electrochemical cell is shown below.

Chemical oxidation occurs at the anode in an active electrochemical cell. Chemical oxidation is a reaction where an atom or molecule gives up electrons.



In this reaction the metal atom, which in combination with the other atoms in a piece of metal has high strength and other metallic properties, is transformed into a metal ion which usually dissolves. The electron is available for transfer to another site of lower electrical potential.

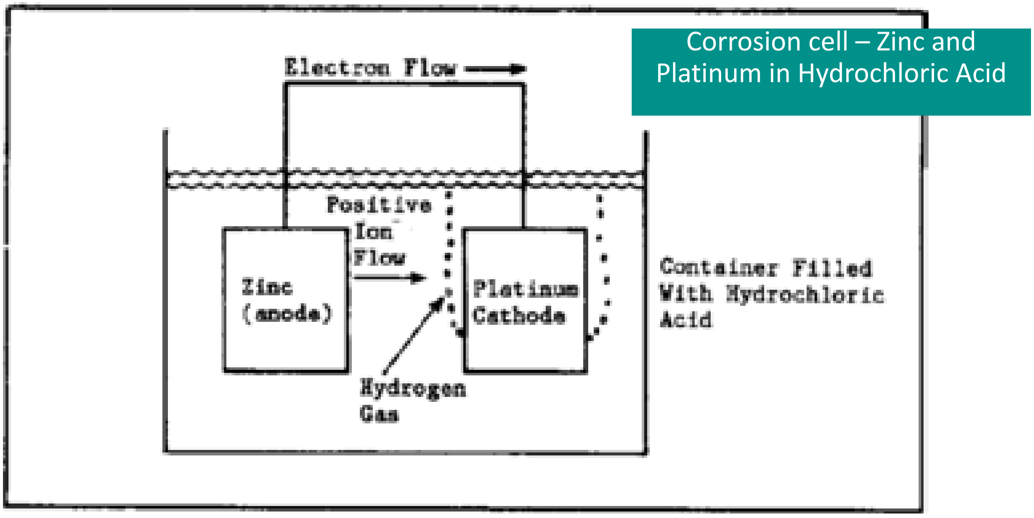
At the cathode in an active electrochemical cell, chemical reduction occurs. Chemical reduction is a reaction where an atom or molecule gains electrons.

A reduced atom may either be discharged as a gas or may be deposited on the cathode. The electrolyte in an electrochemical cell serves as a source of material for the chemical reactions, a medium for the deposition of the products of the chemical reactions, and a path for the flow of charged ions in solution. The electron path, usually a metallic connection, is required so that the electrons produced at the anode can flow from the anode to the sites at the cathode where they are consumed. The electrochemical cell consists of an anode where electrons are produced by a chemical reaction, a cathode where electrons are consumed by a chemical reaction different than the one occurring at the anode, an electrolyte for the flow of ions, and a metallic path for the flow of electrons (dc current).

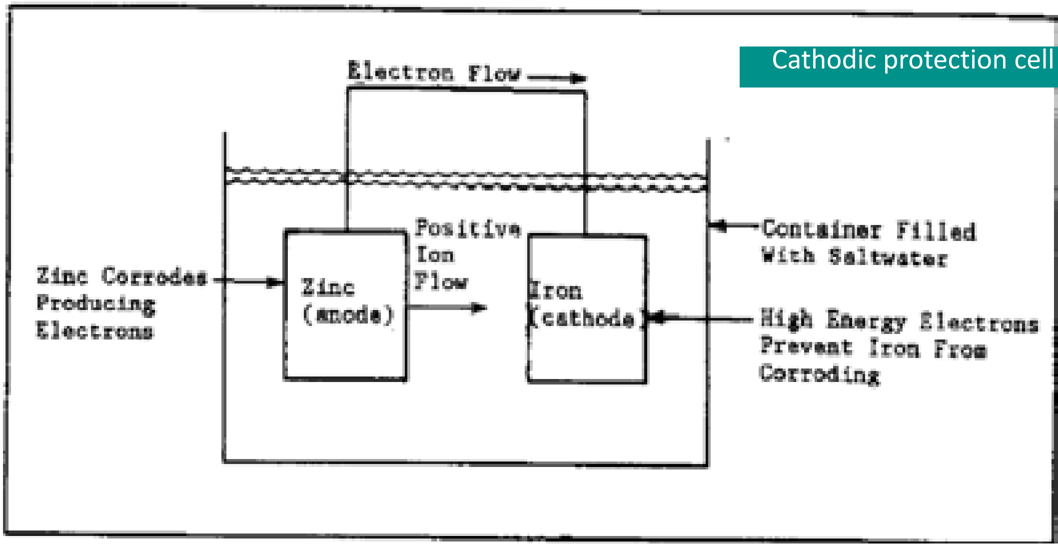
- **Cathodic Protection**

The figure below shows an example of a corrosion cell where zinc is connected to platinum in hydrochloric acid. The zinc corrodes at the anode, hydrogen gas forms at the cathode, and electric current flows through the external electron path. This electric current can be made to do useful work.

An ordinary dry cell battery is an electrochemical cell. When in storage, the electron path is not completed and the electrochemical reaction which produces the current is only allowed to proceed when the external metallic path is completed.



Cathodic protection utilizes a flow of direct current electricity to interfere with the activity of the electrochemical cell responsible for corrosion. As shown in the diagram below, corrosion can be prevented by coupling a metal with a more active metal when both are immersed in an electrolyte and connected with an external path. In this case the entire surface of the metal being protected becomes a cathode; thus the term ***"cathodic protection."***



Cathodic protection cell

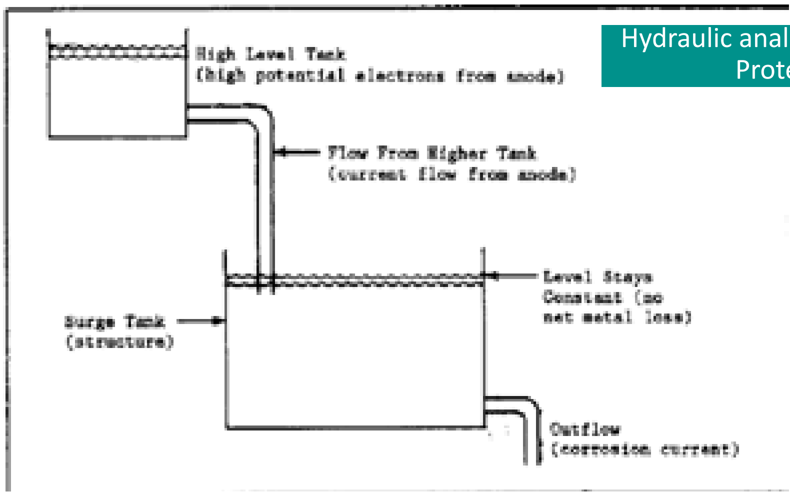
Potentials Required for Cathodic Protection

Every metal immersed in an electrolyte develops an electrochemical potential due to the free energy of the atoms in the metal. To prevent anodic reactions from occurring due to electrochemical reactions on that metal, electrons must be prevented from leaving the metal. Since electrons can only flow from an area of high (negative) potential to an area with lower (negative) potential, connection of the metal to be protected to a source of more negative electrons can effectively prevent the anodic reaction on the metal to be protected and can thus prevent corrosion. In this case, the flow of electrons is from the external source to the metal being protected. Conventional current flow is described by the flow of imaginary positive charges in a direction opposite the electron flow.

Since cathodic protection depends on the energy of electrons and their tendency to flow only from an area of high (negative) potential to one of lower (negative) potential, the principle of cathodic protection can also be demonstrated through a hydraulic analogy (as seen in sketch below). In this analogy the surge tank is the metal to be protected. Flow from the surge tank is prevented by coupling the tank to a supply of water at higher pressure, leaving the tank full.

- **Application**

Cathodic protection is only one of the many methods of corrosion control. Cathodic protection should be evaluated as one alternative method to control corrosion in an overall corrosion control program. Application of cathodic protection should be evaluated on the basis of technical feasibility, economic analysis, and system functional requirements such as reliability and consequence of failure. In some cases (e.g., underground pipelines), field experience has shown that cathodic protection is such an effective means of providing the required levels of safety in the operation of the systems that cathodic protection is required by USA's Federal regulation.



Hydraulic analogy of Cathodic Protection

Cathodic protection should be considered, possibly in conjunction with other forms of corrosion control such as the application of protective coatings, wherever the system is exposed to an aggressive environment in such a manner that cathodic protection is technically and economically feasible.

- **Feasibility**

Cathodic protection is primarily feasible when the surfaces to be protected are buried or submerged. External surfaces of buried metallic structures, surfaces of metal waterfront structures such as sheet pilings or bearing piles, and the internal surfaces of tanks containing electrolytes such as water are applications where cathodic protection is usually technically feasible and is commonly utilized in protecting such structures. Cathodic protection has limited applicability on internal surfaces of small diameter pipelines and other areas where ion flow in the electrolyte is restricted by electrolyte resistance.

When construction of a new buried or submerged system is being planned, the corrosivity of the environment should be considered as one of the factors in the design of the system. If experience with similar systems in the vicinity of the construction site has shown that the site conditions are aggressive based upon leak and failure records, cathodic protection should be provided as a means of controlling corrosion on the new system. Cathodic protection is one of the few methods of corrosion control that can be effectively used to control corrosion of existing buried or submerged metal surfaces. Thus, if leak records on an existing system show that corrosion is occurring, cathodic protection may be applied to stop the corrosion damage from increasing. Cathodic protection can, however, only stop further corrosion from occurring and cannot restore the material already lost due to corrosion.

- **Regulatory Authority**

Regulations by the Department of Transportation (DOT) in USA have established standards for the transportation of certain liquids and compressed gas by pipelines in order to establish minimum levels of safety. These regulations require that these pipelines be protected by cathodic protection combined with other means of corrosion control such as protective coatings and electrical insulation. These regulations provide excellent guidelines for the application of cathodic protection to buried and submerged pipelines.

Due to the safety and environmental consequences of system failure, there are also increasing numbers of federal, state, and local governmental regulations regarding the storage and transportation of certain materials that require corrosion control. Many of these regulations either make the application of cathodic protection mandatory on existing facilities as a primary means of corrosion control or allow it to be selected as a means for the mandatory control of corrosion on new facilities.

To be technically feasible, cathodic protection requires that the protected structure be electrically continuous and immersed in an electrolyte of sufficient volume to allow the distribution of current onto the structure.

Electrical continuity of the structure to be protected may be through metallic continuity provided by bolting, or welding of the structure. Continuity is often achieved or insured by means of electrical connections installed specifically to insure the effectiveness of cathodic protection. These connections are commonly called “bonds.”

The electrolyte is commonly water, or the water contained in moist earth. The conductivity of the electrolyte is an important factor in the determination of the need for cathodic protection and in the design of cathodic protection systems.

Source of Current: Cathodic protection also requires the presence of a source of electrical current at the proper voltage or potential to prevent attack on the structure. These sources of current are commonly called “anodes.” As described below, the anodes may be fabricated from an active metal such as magnesium, or zinc which provides a high potential source of electrons through corrosion on its surface. The anodes may also be fabricated from a relatively inert material which has the ability to pass current from its surface without being consumed at a high rate but which requires the use of an external energy source to increase the potential of the electrons supplied to the structure being protected. Anodes made from active metal are commonly called “sacrificial” or “galvanic” anodes, as the anode material is sacrificed to protect the structure under protection. The inert anodes are commonly called “impressed current” anodes as the external energy source is used to impress a current onto the structure under protection.

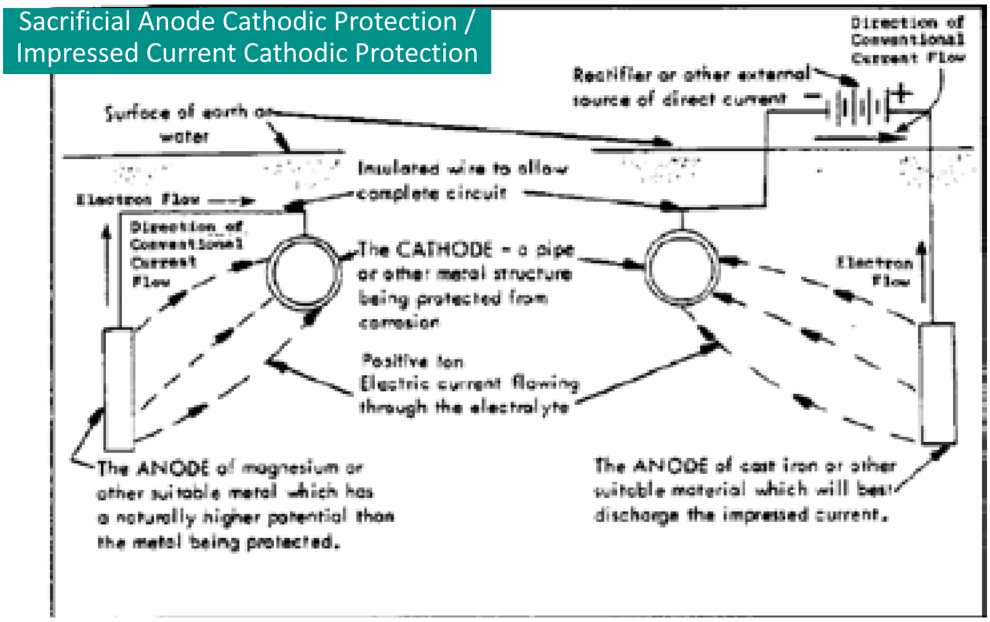
Connection to Structure: The anodes must be electrically connected to the structure through a metallic connection to complete the circuit of the electrochemical cell responsible for the protection of the structure.

❖ Sacrificial Anode Systems

Cathodic protection in the sacrificial anode system is essentially a controlled electrochemical cell (as seen in the figure below).

Corrosion on the protected structure is shifted to the anode. The anode is consumed in the process but is designed and installed so that it is easily replaced when consumed. Anode life of 10 to 15 years is common. Anode life is dependent upon the amount of current emitted by the anodes and their size.

If the cathodic protection system is properly designed and installed, and if it is properly maintained (including periodic replacement of anodes as necessary), the structure being protected is essentially immune to corrosive attack and its lifetime is limited by other factors such as mission requirements or mechanical damage.

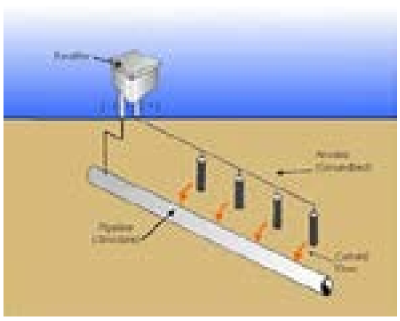


Anode Materials: The materials used for sacrificial anodes are either relatively pure active metals such as zinc or magnesium, or alloys magnesium or aluminum that have been specifically developed for use as sacrificial anodes. In applications where the anodes are buried, a specific chemical backfill material surrounds the anode in order to insure that the anode will produce the desired output.

Connection to Structure: Sacrificial anodes are normally supplied with either lead wires or cast-in straps to facilitate their connection to the structure being protected. The lead wires may be attached to the structure by welding or mechanical connections. These should have a low resistance and should be insulated to prevent increased resistance or damage due to corrosion. Where anodes with cast-in straps are used, the straps should be welded directly to the structure if possible, or, if welding is not possible, used as locations for attachments using mechanical fasteners. A low resistance mechanically adequate attachment is required for good protection and resistance to mechanical damage. Welded connections are preferred to avoid the increase in resistance that can occur with mechanical connections.

Other Requirements: As for all systems to be protected, the structure being protected by sacrificial anodes must be electrically continuous. The system should also include test stations that are used to monitor the performance and to adjust the system for proper operation. As in all mechanical and electrical systems, cathodic protection systems require periodic inspection, maintenance, and adjustment for satisfactory operation.

❖ Impressed Current Systems



From the standpoint of the structure being protected, cathodic protection using the impressed current method is essentially the same as in the sacrificial anode system. As shown in the figure, the cathodic protection system supplies high energy electrons to the structure being protected and the circuit of the electrochemical cell is completed through the soil. However, in the impressed current system, a supply of direct electrical current is used to develop the potential difference between the anode and the structure being protected. Consumption of the anode is not the driving force for the flow-protective current. A properly designed, installed, and maintained impressed current cathodic protection system is as effective as the galvanic anode type of system in preventing corrosion of the structure being protected.

Anode Materials: The materials commonly used for impressed current cathodic protection have the capability of passing a current into the environment without being consumed at a high rate. Graphite and high silicon cast iron are the most commonly used impressed current cathodic protection anode materials; however, other materials such as magnetite, platinum, and newly developed oxide coated ceramic materials have been successfully used.

For buried anodes, a backfill consisting of carbonaceous material is normally used: to decrease the electrical resistance of the anode; to provide a uniform, low resistivity environment surrounding the anode; and to allow for the venting of gasses produced at the anode surface.

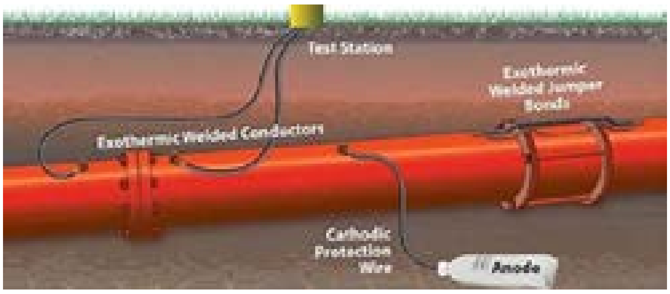
Direct Current Power Source: The supply of direct electrical current used to develop the potential difference between the anode and the structure being protected is normally a rectifier which changes alternating current to direct current of the appropriate voltage and current output.

However, in special applications, other direct current power sources such as solar cells, thermoelectric cells, motor-generator sets, and wind-driven generators may be used.

Connection to Structure: Impressed current cathodic protection anodes are normally supplied with integral lead wires. In impressed current cathodic protection systems, the anodes are connected to the positive terminal of the rectifier and a wire connection is made between the negative terminal of the rectifier and the structure to be protected. The lead wires are connected to the cathodic protection system by welding or mechanical connections. These should have a low resistance and should be insulated to prevent increased resistance or damage due to corrosion. In applications where multiple anodes are used, the individual anode lead wires are often attached to a larger header cable which is connected to the rectifier. As the wire between the rectifier and the anode is under a high positive potential, very rapid attack of the wire will occur where there is a break in the wire insulation and the wire comes in direct contact with the electrolyte. The insulation on this cable is very critical and high quality insulation and care in installation is required for this application.

❖ Other Requirements

As for all systems to be protected, the structure being protected by impressed current must be electrically continuous. The system should also include test stations which are used to monitor the performance and to adjust the system for proper operation. As in the case of sacrificial anode systems, impressed current cathodic protection systems require periodic inspection, maintenance, and adjustment for satisfactory operation.



Contributed by:

Subhash Bahulekar

References:

1. UFC 3-570-02N: 16 January 2004
2. Corrosion - Wikipedia

Standards:

1. IS 8062-4: Code of Practice for Cathodic Protection of Steel Structures
2. IS 12560: Code of Practice for Cathodic Protection of Heat exchangers and Condensers
3. ISO 12473: General principles of Cathodic Protection in Seawater

Cathodic Protection: Preventing Corrosion and Industrial Hazards

Cathodic protection (CP) is an electrochemical technique used to mitigate or prevent corrosion on metal surfaces, particularly in underground, submerged, or otherwise corrosive environments. It is widely used to protect pipelines, storage tanks, ship hulls, offshore structures, and reinforced concrete.

How Cathodic Protection Works

CP systems work by making the metal structure the cathode of an electrochemical cell, thus inhibiting the oxidation (corrosion) process. This can be achieved by two primary methods:

1. **Sacrificial Anode Cathodic Protection (SACP):** A sacrificial anode, made of a more reactive metal (e.g. zinc, magnesium, or aluminium), is electrically connected to the metal structure to be protected. The sacrificial anode corrodes in place of the protected structure.
2. **Impressed Current Cathodic Protection (ICCP):** An external DC power source (rectifier) is used to supply current to the metal structure, making it the cathode. Inert anodes are used in this system.

Types of Cathodic Protection

1. Sacrificial Anode Cathodic Protection (SACP): Uses a sacrificial anode to drive the reaction.
2. Impressed Current Cathodic Protection (ICCP): Uses an external power source to drive the reaction.

Applications of Cathodic Protection

1. Pipeline Protection: Protects pipelines from corrosion, particularly in underground environments.
2. Marine Protection: Protects ship hulls, offshore platforms, and other marine structures from corrosion.
3. Reinforced Concrete Protection: Protects reinforced concrete structures, such as bridges and buildings, from corrosion.

Example: CP in Hazardous Area Pipelines

Consider a natural gas pipeline running through an area classified as Zone 1 or Zone 2 hazardous area (where explosive gases may be present). In this scenario, CP is crucial to prevent corrosion that could lead to leaks and potential explosions. ICCP systems are often used because they can provide a higher level of protection over long distances. The design must account for:

- **Explosion-proof Enclosures:** Rectifiers and other electrical equipment must be housed in explosion-proof enclosures (compliant with IEC 60079 series) to prevent ignition of any surrounding explosive atmosphere.
- **Intrinsically Safe Circuits:** Instrumentation used to monitor CP performance (e.g. reference electrodes, and test stations) should utilize intrinsically safe circuits to limit the energy available in the hazardous area, as per relevant IEC standards.
- **Earthing and Bonding:** Proper earthing and equipotential bonding are essential to minimize the risk of spark hazards and stray currents. This is guided by IEC 60364 and other relevant standards.
- **Designated Personnel:** As per the CEA Regulations, only designated and trained personnel are allowed to install, operate, and maintain the CP system in such hazardous areas.

Benefits of Cathodic Protection

1. Extended Lifespan: CP can significantly extend the lifespan of metal structures.
2. Reduced Maintenance: CP reduces the need for frequent repairs and replacements.
3. Cost Savings: CP can save costs associated with corrosion damage and maintenance.
4. Enhanced Safety: Prevents catastrophic failures and accidents.

Limitations and Challenges

1. Interference: CP can be affected by electrical interference from other sources.
2. Anode Depletion: Sacrificial anodes can deplete over time, requiring replacement.
3. Complexity: CP systems can be complex to design and install.
4. Monitoring: Requires regular monitoring and adjustment to remain effective.

Electrical Safety in CP Systems & Relevant Standards

While there is no specific IEC standard exclusively focused on cathodic protection (CP) systems, several IEC standards address aspects relevant to electrical safety in CP systems.

The following standards are to be followed in sequence as there is no specific Indian Standards for CP:

1. **IEC (International Electrotechnical Commission) Standard**
2. Institute of Electrical and Electronic Engineers (IEEE) Standard
3. European Norms (EN) Standard

Here's a listing of relevant IEC standards:

1. **IEC 60079 series:** These standards cover electrical equipment in explosive atmospheres, which is relevant for CP systems installed in environments where flammable gases or vapors might be present. "Intrinsically safe apparatus" should be used in circuits.
2. **IEC 61508 series:** Focuses on functional safety of electrical/electronic/programmable electronic safety-related systems. This can be applicable to safety-related functions within CP systems.
3. **IEC 61000 series:** Deals with electromagnetic compatibility (EMC), ensuring that CP systems do not interfere with other electrical equipment and vice versa.
4. **IEC 60364 series:** Covers electrical installations and protection against electric shock, which is relevant for the installation and operation of CP systems in various environments.

For specific safety considerations in CP systems, such as diver safety and hazardous area protection, standards like **IMCA D 045** are often referenced, which in turn may refer IEC standards for safe current limits (e.g. IEC 60479). However, these are not IEC standards themselves but rather industry guidelines that incorporate IEC principles.

In addition to the above, the CEA regulations 2023 India defines "Designated person" as a person whose name appears in the record maintained under sub-regulation (2) of regulation 3 by the supplier or consumer, or the owner, agent or manager of all electrical installations, or the agent of any company operating in an oil-field or the owner of a drilled well in an oil-field or a contractor, ensuring only qualified individuals handle electrical work. Such a person needs to have complete knowledge of Cathodic protection while working at places like Ships, Pipelines, etc.

Overall, cathodic protection is a widely used and effective technique for preventing corrosion on metal surfaces, and adherence to relevant safety standards is critical for its safe and reliable operation.

Compiled by:

Mr. Veejhay Limaaye

Cathodic Protection
fight against corrosion and protects valuable asset

Corrosion: The invisible enemy of the industry

Corrosion is a natural process that converts a refined metal into a more chemically stable oxide. It is the gradual deterioration of materials by chemical or electrochemical reaction with their environment.
Corrosion in industry can have devastating consequences that can cause problems in structures and equipment. From material degradation to costly downtime, corrosion can significantly affect the profitability and safety of businesses.

Consequences of negative impact of corrosion in industry

Economic losses: According to studies, it is estimated that the losses caused by corrosion in the oil and gas industry exceed 1.4 trillion dollars annually. These costs are due to repairs, equipment replacement, lost production, and downtime.
Reduction of the useful life of the equipment: Accelerates the process of degradation of the equipment, decreasing it's useful life. Exposed to corrosive environments, such as pipelines, storage tanks, metal structures, and drilling equipment, they are subject to premature wear and require frequent replacement. This generates high maintenance costs and affects operational efficiency.
Safety risks: Structural weakening caused by corrosion often leads to catastrophic failure of equipment and structures, increasing the risk of accidents, releases of hazardous substances, and spills. These incidents can have significant environmental and human consequences.

Cathodic Protection for Steel

Cathodic Protection is one of the most effective methods for preventing corrosion on a metal surface. Cathodic protection is commonly used to protect numerous steel structures against corrosion, such as ships, offshore floaters, subsea equipment, harbours, pipelines, tanks; basically all submerged or buried metal structures.
The first application of cathodic protection (CP) can be traced back to 1824, when Sir Humphry Davy, in a project financed by the British Navy, succeeded in protecting copper sheathing against corrosion from seawater by the use of iron anodes.

Mechanics of Cathodic Protection

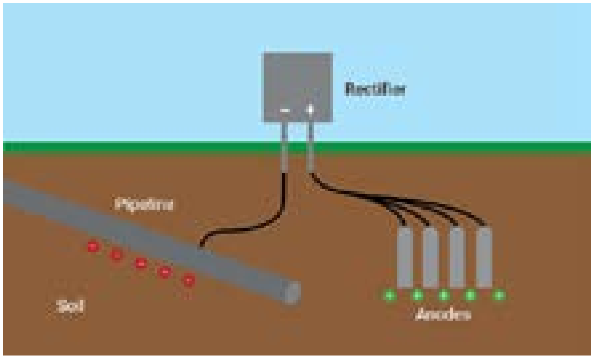
Cathodic protection for steel operates by shifting the electrical potential of the steel structure to a more negative value. This is achieved by supplying electrons to the steel, either through the natural corrosion of a sacrificial anode or via an impressed current. The steel structure typically acts as an anode in a corrosive environment, losing electrons and corroding.The steel becomes the cathode in the electro chemical reaction by introducing a more active metal (in sacrificial systems) or applying an external current (in impressed current systems). This reversal prevents the loss of metalions from the steel, effectively halting corrosion.

Types of Cathodic Protection Systems

(1) **Sacrificial Anode Systems:** Also known as galvanic cathodic protection, this method utilizes a more electrochemically active metal (the sacrificial anode) to protect the steel structure. Common materials for sacrificial anodes include zinc, aluminium, and magnesium. These anodes naturally corrode over time, "sacrificing" themselves to protect the steel. Sacrificial anode systems are often preferred for smaller structures or in areas where power supply is limited.

(2) **Impressed Current Systems:** This approach to cathodic protection for steel employs an external power source to apply a direct current to the steel structure.

The current is typically supplied through inert anodes made of materials like mixed metal oxides, platinum, or graphite. Impressed current systems allow for more precise control and are often used for larger structures or in highly corrosive environments where cathodic protection for steel needs to be more robust.



Benefits of Cathodic Protection

The implementation of cathodic protection for steel offers several significant advantages:

Extended Lifespan: cathodic protection can dramatically extend the service life of steel structures, often by decades. This is particularly crucial for critical infrastructure that would be costly or difficult to replace.

Cost-Effectiveness: While there are initial installation costs, cathodic protection for steel can significantly reduce long-term maintenance and replacement expenses. The investment in a properly designed cathodic protection system often pays for itself many times over during the lifetime of the protected structure.

Environmental Advantages: By reducing the need for frequent replacements and repairs, cathodic protection for steel helps conserve resources and minimize environmental impact.

Versatility: Cathodic protection for steel can be appliedto both new constructions and existing structures,protecting various environments. This flexibility makes ita valuable tool in a wide range of applications.

Contributed By

Mahesh Panchal
AMPP Sr. Corrosion Technologist
AMPP Cathodic Protection Level-III
AMPP Cathodic Protection Level-II **Link for original tariff petition filed by MSEDCL with MERC**
Link for original tariff petition filed by MSEDCL with MERC

Major demands

- To approve revised ToD tariff structure and allow MSEDCL to approach itself each year of 5th Control period regarding changes in ToD charges and slabs.
- To approve levy of Grid Support Charge as calculated by MSEDCL
- To approve kVAh based billing for LT consumers above 20 kW
- To approve revised methodology for billing of residential consumers with Rooftop Solar System.
- To approve revised 'Green Tariff' and Green RTC power for sunshine industries like data centers and semi-conductor.
- To approve discount in Demand Charges for Single Shift operation of HT-Industry which are operational for at-least 8 hours during solar hours.
- To allow the revision in definition of Billing Demand as proposed by MSEDCL
- To approve Cross Subsidy Surcharge and all such other charges including wheeling charges and wheeling losses for Open Access consumers as proposed for the Control Period;

Expected Impact.

1. Now onwards, TOD benefit will be available only from 9am to 5pm i.e. daytime and the same would be Rs. 2.15/kVAh. Rest of all slots' rates will be "tariff + Rs. 1.XX". Rs. 0.80 TOD rebate will be available for above slot even for residential consumers.
2. Rebates and incentives will be available only to those who buy their entire demand from MSEDCL.
3. Maximum demand considered while deciding Billing demand will be maximum demand recorded between 06:00 AM to 22:00PM.
4. For those who are using Net metering with roof top solar are expected to pay "Grid support charges" @ Rs. 1.XX/kWh for LT consumers and Rs. 0.7X for HT consumers.
5. KVAh billing is expected to start with all (including LT consumers) above sanctioned load of 20kW.
6. Cross subsidy of Rs. 2.XX per kWh on PPA receipts and wheeling charge of Rs. 0.76 for HT and Rs. 1.46 For LT consumer will be charged. Additional surcharge of Rs. 1.4X is also demanded on these PPA purchases.
7. Billing demand charges are expected to increase as minimum chargeable demand would be 85% of contract demand and per KVA rates are expected to increase to Rs. 600/-, 620/-, 720/-, 730/-, 750/- per KVA in next 5 years.
8. Now for residential roof top net metering – "The balance units if any" will be charged at "Slab of Total import and not on net import. Example on page 9.

New TOD Tariff structure

Table 183 Calculated ToD Charges and Rebates for Industrial Category (Rs/unit)

Time Slot	10 pm to 6 am	6 am to 9 am	9 am to 5 pm	5 pm to 10 pm
FY 2025-26	1.00	1.15	(2.15)	1.30
FY 2026-27	1.15	1.10	(2.35)	1.45
FY 2027-28	1.20	1.20	(2.45)	1.55
FY 2028-29	1.20	1.20	(2.40)	1.50
FY 2029-30	1.15	1.20	(2.35)	1.40

Table 184 Calculated ToD Charges and Rebates for Commercial Category (Rs/unit)

Time Slot	10 pm to 6 am	6 am to 9 am	9 am to 5 pm	5 pm to 10 pm
FY 2025-26	0.90	1.25	(2.15)	1.40
FY 2026-27	1.05	1.20	(2.35)	1.55
FY 2027-28	1.10	1.30	(2.45)	1.65
FY 2028-29	1.10	1.30	(2.40)	1.60
FY 2029-30	1.05	1.30	(2.35)	1.50

Table 185 Calculated ToD Charges and Rebates for other categories with ToD tariff (Rs/unit)

Time Slot	10 pm to 6 am	6 am to 9 am	9 am to 5 pm	5 pm to 10 pm
FY 2025-26	1.15	1.15	(2.15)	1.15
FY 2026-27	1.30	1.10	(2.35)	1.30
FY 2027-28	1.35	1.20	(2.45)	1.40
FY 2028-29	1.35	1.20	(2.40)	1.35
FY 2029-30	1.30	1.20	(2.35)	1.25

Table 186 Calculated ToD Charges and Rebates for Domestic Category (Rs/unit)

Time Slot	10 pm to 6 am	6 am to 9 am	9 am to 5 pm	5 pm to 10 pm
FY 2025-26	-	-	(0.80)	-
FY 2026-27	-	-	(0.85)	-
FY 2027-28	-	-	(0.90)	-
FY 2028-29	-	-	(0.95)	-
FY 2029-30	-	-	(1.00)	-

Grid Support Charges:

6.5.11 MSEDCL would further submit that solar energy is generated during daytime and after self-consumption by the consumer the balance energy is fed into the grid. Due to its combined impact, the utility has to back down thermal generation but is obligated to pay the same fixed cost to generators. When there is no Solar Generation (evening, seasonal change, technical problem in system etc.), the consumer draws full power as per requirement from the grid and utility has to keep network and generators on bar ready to feed this demand. The consumer is using the grid as a storage system for his solar rooftop arrangement under net metering and at the same time loading the balance costs on other consumers of the distribution utility such as generators fixed cost, infrastructure cost recovery, CSS, etc.

6.5.12 MSEDCL further submits that Grid Support Charges are applicable on consumers with above 10 kW sanctioned load which are generally high-end LT/

Table 191 Estimated revenue from approved Grid Support Charge

Voltage Level	Approved GSC (Rs/unit)	RTS consumption (MU)	Total Revenue from GSC (Rs Crore)
LT	1.16	3,302	383.03
HT	0.72	1,754	126.29
Total		**5,056**	**509.32**

K. Cross-Subsidy Surcharge (CSS)

Section 2 (47) of the Electricity Act defines "Open Access', while Section 42 of the said Act inter – alia mandates the Distribution Licensee to provide Open Access to eligible consumers, subject to payment of "Cross Subsidy Surcharge", "Additional Surcharge" & other applicable charges.

As per the provisions of Section 42(2) of the Electricity Act 2003, the CSS needs to be based on the current levels of cross subsidy. Accordingly, the consumers who opted for Open Access need to be charged for the compensation of current level of Cross Subsidy, which prevailed during that period and in order to avoid the burden of the same being passed on other consumers who are with the Distribution Licensee.

Accordingly, MSEDCL has calculated the CSS based on the National Tariff Policy (NTP) formula with ceiling. A representative Cross Subsidy Surcharge for HT Industrial Category has been tabulated below:

Cross Subsidy Surcharge for HT Industrial Category

Category	FY 2025-26	FY 2026-27	FY 2027-28	FY 2028-29	FY 2029-30
HT I – HT Industry					
HT	2.18	2.26	2.28	2.15	2.12
EHV	2.18	2.26	2.28	2.15	2.12

Particulars	Units	FY 2025-26	FY 2026-27	FY 2027-28	FY 2028-29	FY 2029-30
PU Wheeling Charges						
HT (Excl EHV)	Rs/kVAh	0.76	0.83	0.86	0.88	0.87
LT Level	Rs/kWh	1.46	1.60	1.67	1.71	1.71

M. Additional Surcharge

Section 42(4) of the Electricity Act provides for the levy of Additional Surcharge to a consumer who receives supply of electricity from a person other than the distribution licensee of his area of supply.

Amendment to MERC Distribution OA Regulations, 2023 has exempted Green Energy Open Access consumers paying Demand charges to pay Additional Surcharge, MSEDCL has not envisaged any income from Levy of Additional surcharge from the Green Energy Open Access customers in the Control Period. MSEDCL has envisaged the levy of such Additional surcharge only from the conventional IPP Open Access consumers.

Summary of Additional Surcharge for the Control Period for FY 2025-26 to FY 2029-30 is provided in the table below:

Summary of Additional Surcharge for the Control Period FY 2025-26 to FY 2029-30

Particulars	FY 2025-26	FY 2026-27	FY 2027-28	FY 2028-29	FY 2029-30
Proposed Additional Surcharge (Rs/unit)	1.41	1.43	1.53	1.51	1.59

N. Tariff Applicability

Every consumer of electricity has a unique applicability of tariff, depending upon the nature of power supply, purpose of power usage etc. which determines the class of consumer or category of the consumer. The Hon'ble Commission has accordingly classified the consumers of electricity into various categories depending upon the nature of power supply i.e. (Low Tension or High Tension), purpose of power/type of usage i.e. (Domestic, Non-domestic, Industrial, Agricultural, etc.)

MSEDCL has examined the tariff applicability and based on the feedback received during interactions with field officers, MSEDCL has proposed certain modifications in applicability of tariff.

Category	FY 25-26 (Proposed)					FY 25-26 (% Increase)				
	FC	EC	WC	VC	ABR	FC	EC	WC	VC	ABR
	Rs./kVA/M	Rs./Unit	Rs./Unit	Rs./Unit	Rs./Unit	Rs./kVA/M			Rs./Unit	Rs./Unit
HT I HT - Industry										
HT	600	8.71	0.76	9.47	11.09	9.29%	4.15%	28.55%	-1.21%	0.55%
EHV	600	8.71	-	8.71	10.50	9.29%	4.15%		-3.00%	0.10%
HT I (A) (i): HT - Industry Sub-total	-	-	-	-	**10.91**					**0.42%**
HT I (B): HT - Industry (Seasonal)										
HT	600	8.71	0.76	9.47	13.00	9.29%	0.31%	28.55%	-5.67%	-9.93%
EHV	600	8.71	-	8.71	11.05	9.29%	0.31%		-6.34%	-4.49%
HT I (B): HT - Industry (Seasonal) Sub-total	-	-	-	-	**12.98**					**-9.86%**
HT I : HT - Industry Total	-	-	-	-	**10.92**					**0.39%**
HT II: HT – Commercial										
HT	600	14.03	0.76	14.80	16.88	9.29%	6.21%	28.55%	0.16%	-0.85%
EHV	600	14.03	-	14.03	18.13	9.29%	6.21%		-0.33%	13.34%
HT II : HT - Commercial Total	-	-	-	-	**16.91**					**-0.35%**

FC: Fixed charges

EC: Energy Charges

WC: Wheeling Charges

+ / - effect of TOD and other charges along with taxes and duties will be extra.

Category	FY 26-27 (Proposed)					FY 26-27 (% Increase)				
	FC	EC	WC	VC	ABR	FC	EC	WC	VC	ABR
	Rs./kVA/M	Rs./Unit	Rs./Unit	Rs./Unit	Rs./Unit	Rs./kVA/M			Rs./Unit	Rs./Unit
HT I HT - Industry										
HT	675	8.85	0.83	9.69	11.48	12.50%	1.67%	8.95%	2.26%	3.44%
EHV	675	8.85	-	8.85	10.89	12.50%	1.67%		1.67%	3.74%
HT I (A) (i): HT - Industry Sub-total	-	-	-	-	**11.30**					**3.57%**
HT I (B): HT - Industry (Seasonal)										
HT	675	8.85	0.83	9.69	13.55	12.50%	1.67%	8.95%	2.26%	4.26%
EHV	675	8.85	-	8.85	11.42	12.50%	1.67%		1.67%	3.40%
HT I (B): HT - Industry (Seasonal) Sub-total	-	-	-	-	**13.54**					**4.26%**
HT I : HT - Industry Total	-	-	-	-	**11.31**					**3.57%**
HT II: HT – Commercial										
HT	675	14.75	0.83	15.58	17.82	12.50%	5.14%	8.95%	5.34%	5.60%
EHV	675	14.75	-	14.75	19.31	12.50%	5.14%		5.14%	6.55%
HT II : HT - Commercial Total	-	-	-	-	**17.86**					**5.62%**

Category	FY 27-28 (Proposed)					FY 27-28 (% Increase)				
	FC	EC	WC	VC	ABR	FC	EC	WC	VC	ABR
	Rs./kVA/M	Rs./Unit	Rs./Unit	Rs./Unit	Rs./Unit	Rs./kVA/M			Rs./Unit	Rs./Unit
HT I HT - Industry										
HT	720	8.78	0.86	9.64	11.53	6.67%	-0.82%	3.73%	-0.43%	0.49%
EHV	720	8.78	-	8.78	10.98	6.67%	-0.82%		-0.82%	0.84%
HT I (A) (i): HT - Industry Sub-total	-	-	-	-	**11.37**					**0.62%**
HT I (B): HT - Industry (Seasonal)										
HT	720	8.78	0.86	9.64	13.69	6.67%	-0.82%	3.73%	-0.43%	1.07%
EHV	720	8.78	-	8.78	11.48	6.67%	-0.82%		-0.82%	0.51%
HT I (B): HT - Industry (Seasonal) Sub-total	-	-	-	-	**13.68**					**1.07%**
HT I : HT - Industry Total	-	-	-	-	**11.38**					**0.62%**
HT II: HT – Commercial										
HT	720	15.10	0.86	15.96	18.40	6.67%	2.36%	3.73%	2.44%	3.22%
EHV	720	15.10	-	15.10	20.15	6.67%	2.36%		2.36%	4.35%
HT II : HT - Commercial Total	-	-	-	-	**18.44**					**3.25%**

Category	FY 28-29 (Proposed)					FY 28-29 (% Increase)				
	FC	EC	WC	VC	ABR	FC	EC	WC	VC	ABR
	Rs./kVA/M	Rs./Unit	Rs./Unit	Rs./Unit	Rs./Unit	Rs./kVA/M			Rs./Unit	Rs./Unit
HT I HT - Industry										
HT	730	8.10	0.88	8.98	10.87	1.39%	-7.73%	1.45%	-6.91%	-5.75%
EHV	730	8.10	-	8.10	10.34	1.39%	-7.73%		-7.73%	-5.79%
HT I (A) (i): HT - Industry Sub-total	-	-	-	-	**10.72**					**-5.74%**
HT I (B): HT - Industry (Seasonal)										
HT	730	8.10	0.88	8.98	13.02	1.39%	-7.73%	1.45%	-6.91%	-4.91%
EHV	730	8.10	-	8.10	10.80	1.39%	-7.73%		-7.73%	-5.91%
HT I (B): HT - Industry (Seasonal) Sub-total	-	-	-	-	**13.01**					**-4.92%**
HT I : HT - Industry Total	-	-	-	-	**10.73**					**-5.74%**
HT II: HT – Commercial										
HT	730	15.53	0.88	16.41	18.93	1.39%	2.86%	1.45%	2.78%	2.92%
EHV	730	15.53	-	15.53	20.87	1.39%	2.86%		2.86%	3.59%
HT II : HT - Commercial Total	-	-	-	-	**18.98**					**2.93%**

Category	FY 29-30 (Proposed)					FY 29-30 (% Increase)				
	FC	EC	WC	VC	ABR	FC	EC	WC	VC	ABR
	Rs./kVA/M	Rs./Unit	Rs./Unit	Rs./Unit	Rs./Unit	Rs./kVA/M			Rs./Unit	Rs./Unit
HT I HT - Industry										
HT	750	7.97	0.87	8.84	10.74	2.74%	-1.65%	-0.25%	-1.52%	-1.17%
EHV	750	7.97	-	7.97	10.24	2.74%	-1.65%		-1.65%	-0.97%
HT I (A) (i): HT - Industry Sub-total	-	-	-	-	**10.60**					**-1.10%**
HT I (B): HT - Industry (Seasonal)										
HT	750	7.97	0.87	8.84	12.92	2.74%	-1.65%	-0.25%	-1.52%	-0.75%
EHV	750	7.97	-	7.97	10.69	2.74%	-1.65%		-1.65%	-1.03%
HT I (B): HT - Industry (Seasonal) Sub-total	-	-	-	-	**12.91**					**-0.75%**
HT I : HT - Industry Total	-	-	-	-	**10.61**					**-1.10%**
HT II: HT – Commercial										

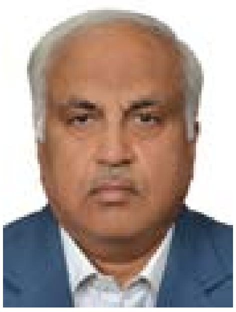
Table 192 Proposed Methodology for adjustment of RTS Generation from LT I (B) Generation(B)

Particulars	Existing Methodology	Proposed Methodology
Total monthly energy consumed by LT I (B) category in billing cycle (kWh)	520	520
Energy Generated by RTS (kWh)	400	400
Net Energy to be billed	120	120
Telescopic Tariff (for FY 2025-26)	Consumption Slab: 1-100 units; 101-300 units; 301-500 units; Above 500 units	Energy Charge (Rs/kWh): 4.37; 11.14; 15.49; 17.63
Calculation of Energy Charge	100 units @ 4.37/kWh (1-100 units) 20 units@ Rs 11.14/kWh(101-300 units consumption slab)	100 units @15.49/kWh (301 – 500 units consumption slab) 20 units @ 17.63/kWh (Above 500 units)
Energy Charge (Rs)	659.80	1,901.60

Link for original tariff petition filed by MSEDCL with MERC

https://www.mahadiscom.in/wp-content/uploads/2025/01/1.-MSEDCL-MYT-Petition_5th-Control-Period-21-Jan.pdf

Prepared by:



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• Three years monthly consumption on display
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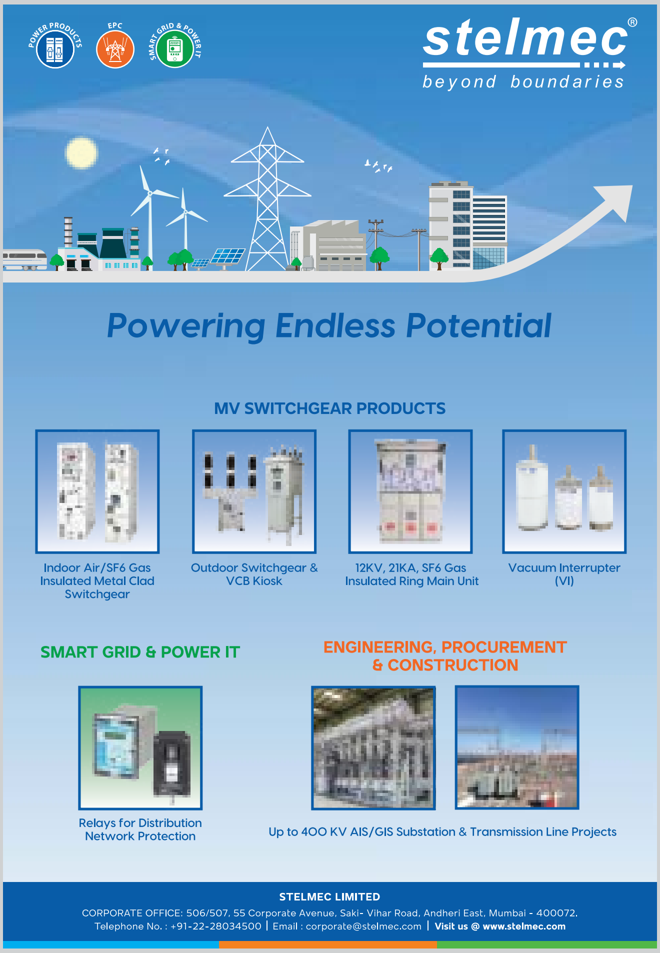
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Congratulations

QUIZ MARCH 2025

1. BESS:
   A. Benzene Ethylene Sodium Sulphate (Synthetic Insulators)
   B. Battery Energy Storage System
   C. Bharat Energy Solutions Society
   D. Battery Eliminated Synthetic Storage

2. 8 AWG:
   A. 8.5 Sq.mm.
   B. 9.0 Sq.mm.
   C. 0.01163 Sq.in.
   D. None of the above

3. The purpose of Electrical Heat Tracing:
   A. Protect pipes, floors, vessels, etc. from freezing
   B. Dehumidify motors and switchgear enclosures
   C. Super heat water before entering boiler tubes
   D. None of the above

4. Type I and Type II co-ordination:
   A. Upstream vs. downstream relay co-ordination
   B. Upstream vs. downstream circuit breaker co-ordination
   C. Type of motor starters selected for SC conditions
   D. Current limiting vs. normal CB

5. Fire Triangle:
   A. Fuel, Heat, and Oxygen
   B. Wood, Ignition Temp., and Air
   C. Both A & B
   D. None of the above

6. In the latest edition of IEC 60079-7, Ex nA is replace by ____ and Ex e by ____:
   A. Ex ec, Ex eb
   B. Ex q, Ex px
   C. Ex d, Ex n
   D. None of the above

7. Scientist born in December:
   A. Kalpana Chawla
   B. Jagdish Chandra Bose
   C. Srinivasa Ramanujan
   D. Jayant Narlikar

8. WMTS (Wireless medical telemetry Service) Frequency Band:
   A. 10 - 50 MHz
   B. 2.4 GHz
   C. 400 MHz, 600 MHz & 1.4 GHz
   D. 3.1 - 10.6 GHz

9. As a minimum requirement, mild steel sheet thickness for cable tray should be:
   A. 2.5 mm
   B. 1.5 mm
   C. 1.0 mm
   D. 4.0 mm

10. Arc flash is measured in thermal energy units of:

- A. A/cm2
- B. Watts/m2
- C. Joules/s
- D. cal/cm2

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/R6cJ8RgesQfzHoHw7

"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.

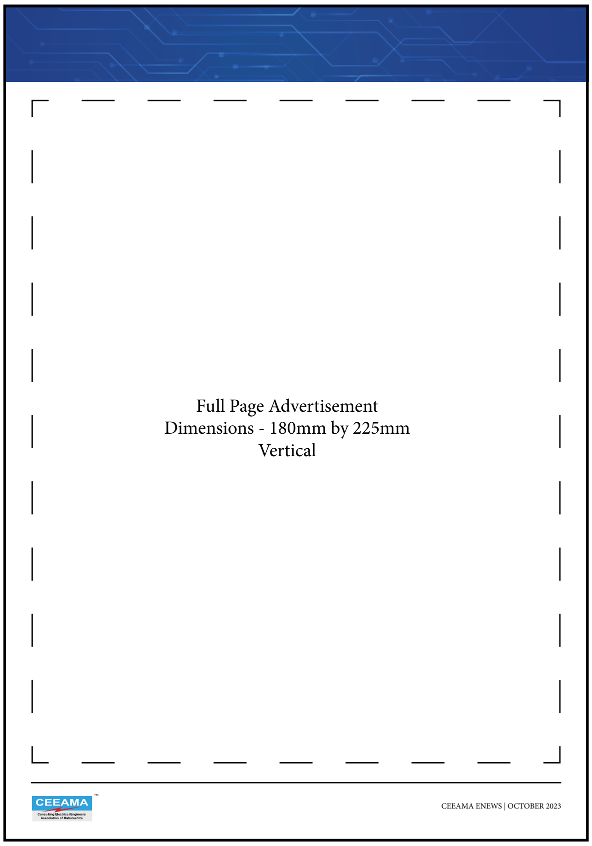
It can open a pandora box for our discussions and arguments and probable solutions. Engineering evolves with conception. It gets fuelled with community discussions and capitalist actions. All stakeholders start realising the need to take a closer look and help improve standards as we have seen in the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

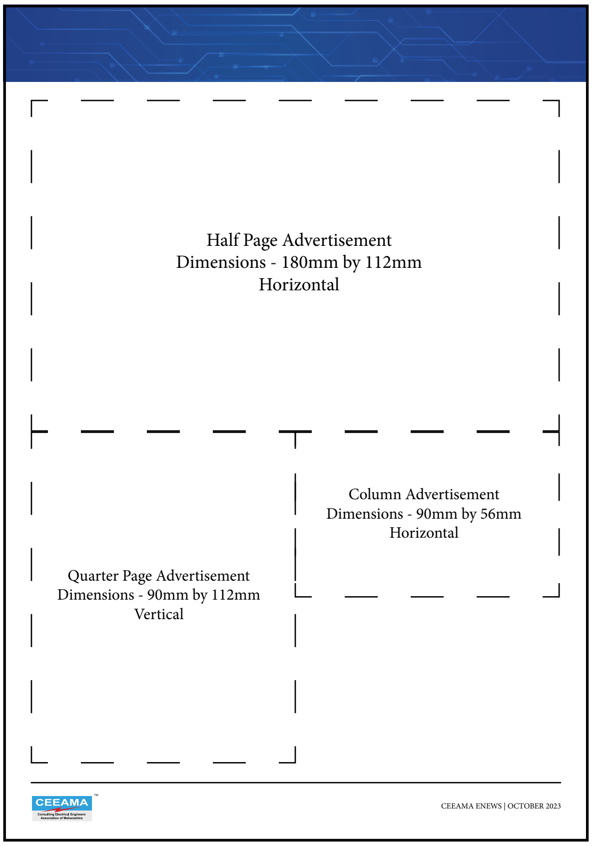
Wish you all a better luck this time.

February 2025 Quiz Answers

1. C. Heat Recovery Steam Generator
2. D. Transport
3. A. Stratosphere
4. B. kW/ton of refrigeration
5. B. Maximum Load
6. B. 0.8
7. C. Both A & B
8. C. Unity power factor
9. D. All the above
10. C. Both A & B

ADVERTISEMENT RATES





Above given layouts are only for understanding the advertisement sizes. Actual positions of ads may vary as per space available in the issues.

Below given rates are for advertisement size and number of issues published monthly.

E-Newsletter Ad	3 months	6 months	9 months	12 months
Full Page Ad	INR 1000/-	INR 2000/-	INR 2700/-	INR 3300/-
Half Page Ad	INR 800/-	INR 1600/-	INR 2200/-	INR 2800/-
Quarter Page Ad	INR 600/-	INR 1200/-	INR 1600/-	INR 2100/-
Column Ad	INR 400/-	INR 800/-	INR 1000/-	INR 1400/-
Website Ad	INR 1000/-	INR 2000/-	INR 2700/-	INR 3300/-

GST @18% will be additional on all the above rates.

Please send the E-Newsletter Advertisement in PDF or JPG format ONLY.

Please send the Website Advertisement in JPG or PNG format ONLY.

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E-NEWSLETTER

Published by Consulting Electrical Engineers Association of Maharashtra

Electrical Consultants Newsletter
Volume No. 4 Issue #48
MARCH 2025

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