CONNECT AND PROTECT

Power Utilities

Comprehensive Electrical Protection Solutions

nVent

ERICO

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Introduction

For over 100 years, nVent ERICO has been an essential supplier of electrical protection for critical infrastructure. We provide reliable, resilient and efficient power and data infrastructure solutions.

Utilities owners, operators and contractors throughout the world trust the expertise and high quality products of nVent ERICO.

We offer a comprehensive range of solutions that are used in power generation facilities, substations, power transmission lines and distribution poles.

GROUNDING AND BONDING

- Ground Rods, Mats, Mesh
- Ground Enhancement Material
- Plates, connectors, assemblies
- Theft Deterrent Conductors

DIRECT STRIKE LIGHTNING PROTECTION

- Active and passive direct strike lightning protection (LP) systems
- Offering includes solutions based on every type of LP methodology (i.e., Fixed Angle, RSM and CVM systems)

NVENT ERICO CADWELD AND CADWELD PLUS

- The premier solution for making exothermic welded grounding bonds with solutions for:
  - Cable to Cable
  - Cable to Ground Rod
  - Cable to Busbar
  - Cable to Lug
  - Cable to Rebar

SURGE PROTECTIVE DEVICES

- Surge Protective Devices for power distribution, discrete signals (inputs and outputs) and communication (data and RF) equipment

Electrical Protection Solutions for Utility Infrastructure

Power Generation Stations

nVent ERICO understands the unique challenges and risks various types of power generation stations face and is well versed in relevant compliance standards throughout the world (IEEE, UL, etc.).

Every type of power generation station, including coal-fired, natural gas, nuclear, hydro-electric and renewables (solar and wind), requires electrical protection. A trusted industry partner, nVent ERICO has helped develop solutions for power generation stations that are now the standard. With this legacy and experience, nVent ERICO is now serving the next generation of renewables with the same reliable, resilient and efficient solutions that connect and protect critical structures and equipment.

Substations

- Substation exposure to lightning strikes, ground faults and transient surges put people and equipment at risk.
- Electronic equipment in substations can be damaged by normal switching surges and other unfavorable conditions (electrical noise, ground potential rise and occasional induced or direct lightning impulses).
- nVent ERICO is a leading provider of grounding and bonding solutions for substation applications. We bring a comprehensive, systematic approach to substation electrical protection.

Electrical Protection Solutions for Utility Infrastructure

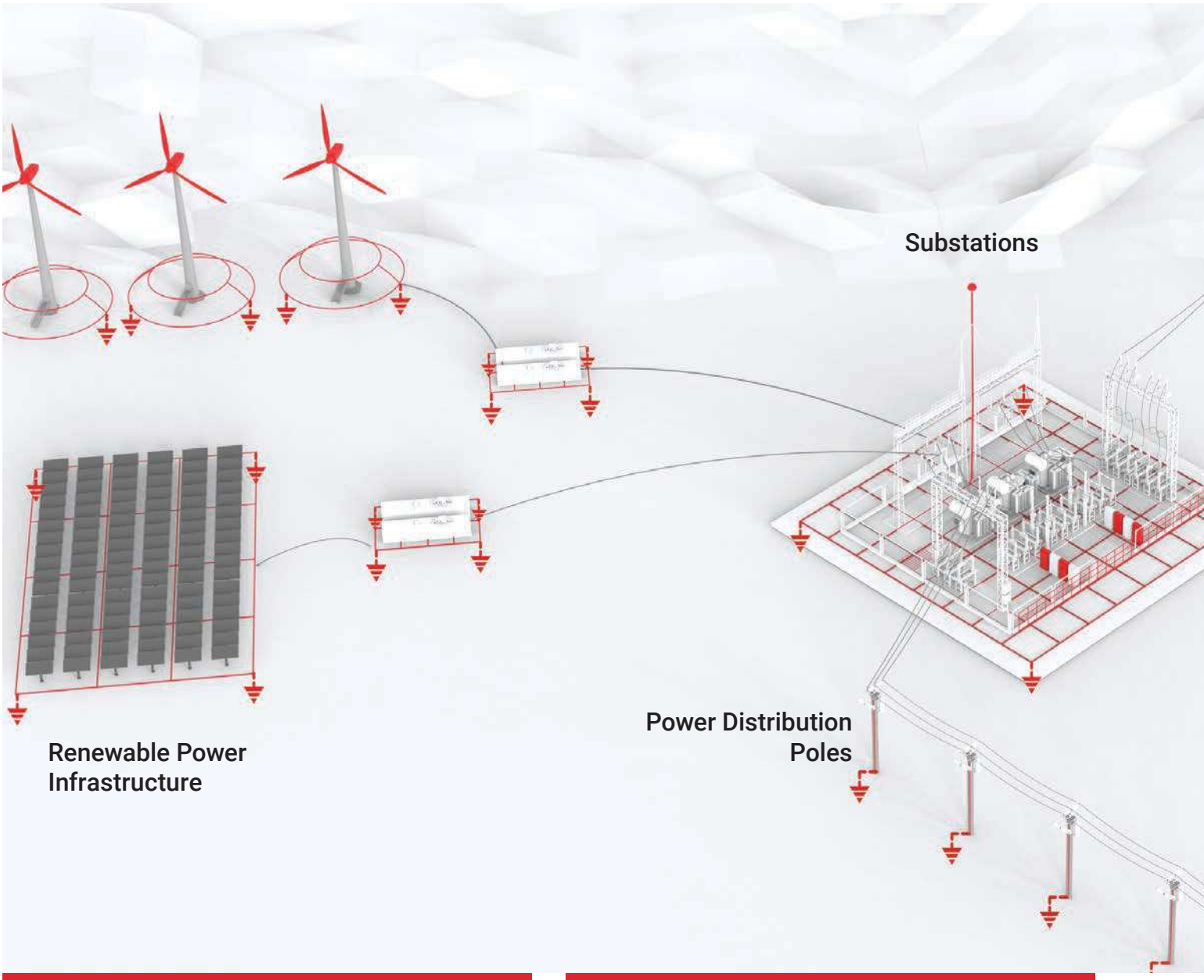
Power Transmission Structures and Distribution Poles

Faults and transient events that affect power transmission towers and distribution poles can put public safety at risk.

nVent ERICO understands all of the considerations and parameters for lightning protection, surge protection and grounding and bonding systems for these applications. We offer solutions specifically designed for transmission and distribution pole applications. Our expertise and niche specialization have established nVent ERICO as a trusted partner in the electrical utility industry.

nVent ERICO provides electrical protection solutions throughout the electrical utilities environment, including power generation stations, substations, power transmission lines and distribution poles.

Electrical Protection from the Grounding Up



Grounding

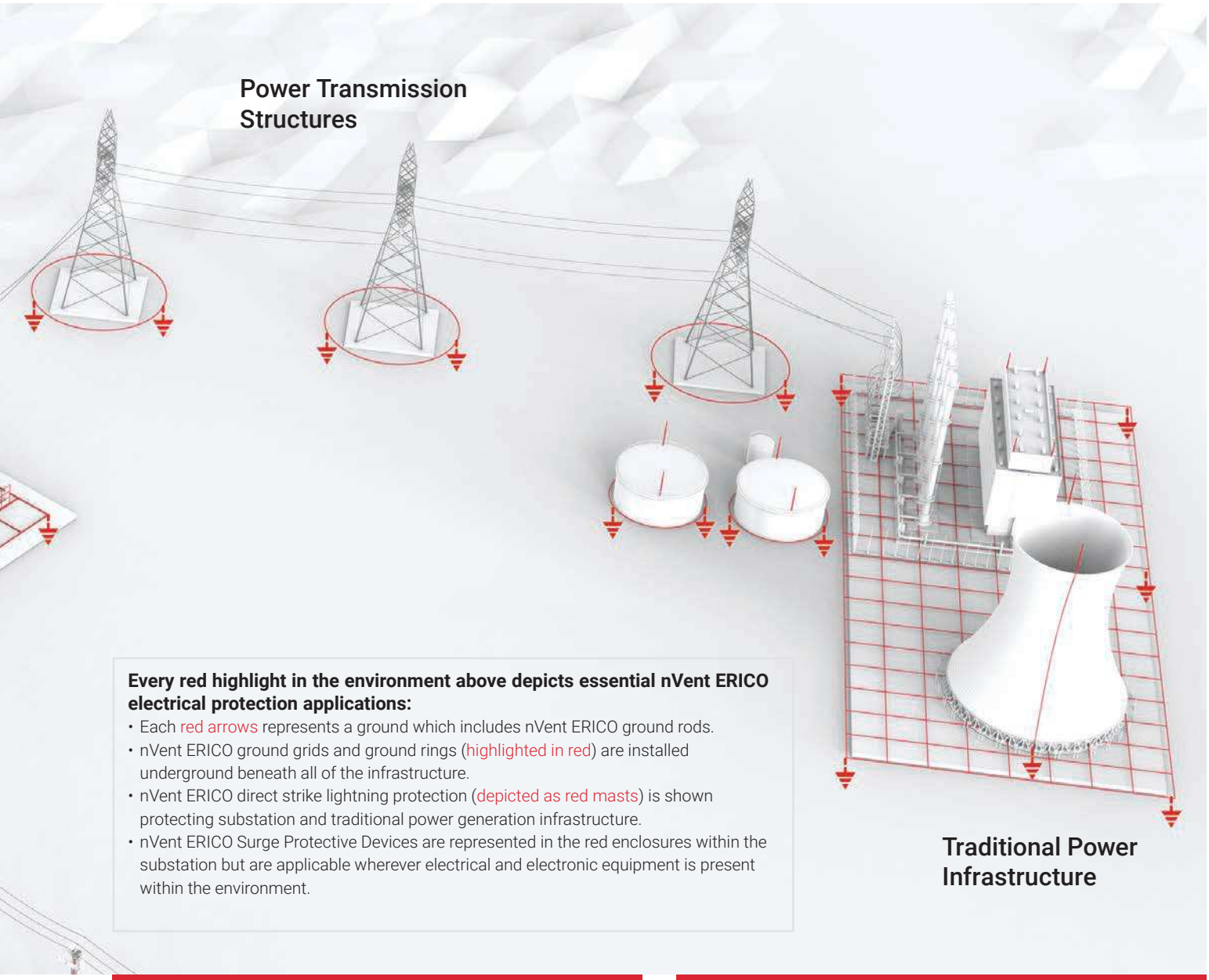
Ground Rods, Mats and Mesh

Specialized Ground Plates and Theft Deterrent Conductors

Ground Enhancement Material

Exothermic Bonds

nVent ERICO Cadweld Plus and Cadweld Plus One Shot



Every red highlight in the environment above depicts essential nVent ERICO electrical protection applications:

- Each red arrows represents a ground which includes nVent ERICO ground rods.
- nVent ERICO ground grids and ground rings (highlighted in red) are installed underground beneath all of the infrastructure.
- nVent ERICO direct strike lightning protection (depicted as red masts) is shown protecting substation and traditional power generation infrastructure.
- nVent ERICO Surge Protective Devices are represented in the red enclosures within the substation but are applicable wherever electrical and electronic equipment is present within the environment.

Lightning Protection

nVent ERICO System 3000 and System 2000

Surge Protective Devices

- **Primary and secondary power protection**
- **Equipment inputs and outputs**
- **Data and signal line protection**

nVent ERICO Capabilities

nVent ERICO Cadweld

Exothermic welds form a permanent, low-resistance bond that will not loosen or corrode over time, making it ideal for utilities infrastructure that relies on long-lasting connections. This makes nVent ERICO Cadweld an essential part of our utilities grounding and bonding system used to ground conductors to ground electrodes. Our comprehensive offering of exothermic bond solutions are the result of our long-term partnership with the electrical utilities industry, where nVent ERICO has developed many dedicated Cadweld products (including molds and weld material) specifically for utilities infrastructure.

NVENT ERICO CADWELD PLUS

nVent ERICO Cadweld Plus features a self-contained weld material cup and electronic ignition unit, which is faster and easier to use.

Self-Contained Weld Cup

Self-contained nVent ERICO Cadweld Plus weld cups will never spill and are resistant to degradation. This ensures that the precise formulation of weld material is always present in an nVent ERICO Cadweld Plus weld, improving weld quality.

Electronic Ignition System

The nVent ERICO Cadweld Plus Impulse Electronic Ignition System allows the user to stand back from the weld at a distance of 6 feet to 15 feet.

A Partner to the Electrical Utilities Industry

nVent ERICO is a committed partner in providing Cadweld exothermic bonding solutions to the utilities industry. We offer ongoing training and certification as well as long-term customer support in the use of nVent ERICO Cadweld.

nVent ERICO Capabilities

nVent ERICO Cadweld

Since its launch in 1939, nVent ERICO Cadweld has been the premier exothermic bonding solution.

nVent ERICO Cadweld is used to make nearly every type of bonded connection, making it an essential part of the grounding and bonding system.

NVENT ERICO CADWELD COMMON UTILITY CONNECTIONS

nVent ERICO Cadweld kits establish the following types of bonded connections:

- Cable to Cable
- Cable to Ground Rod
- Cable to Busbar
- Cable to Lug
- Cable to Rebar

However, this is only a small selection of the broader nVent ERICO Cadweld offering from nVent ERICO - the inventor and industry leader in exothermic grounding.

XB

SS

RR

VB

GR

BB

NVENT ERICO CADWELD PLUS ONE SHOT

The nVent ERICO Cadweld One Shot is a convenient, single-use ceramic mold and welding material connection package. The nVent ERICO Cadweld One Shot is ideal for making permanent reliable connections to ground rods for electrical transmission and distribution and many other industrial applications.

Learn more about nVent ERICO Cadweld, including how to specify, select and install, by visiting cadweld.com

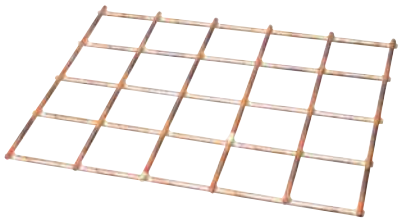
nVent ERICO Capabilities

Grounding and Bonding

nVent ERICO is a global leader in grounding and bonding solutions and has been a trusted partner to the power utility industry for 80 years. Over many decades, we've established expertise and a comprehensive offering that allows us to approach our customers in a collaborative, consultative way to solve problems and ensure the best possible solution is always achieved. We remain committed to supporting electrical utilities customers through our in-house engineering and commitment to R&D.

Ground Rods
World's largest manufacturer of ground rods with a complete offering that includes Copper-Bonded, Solid Copper Stainless Steel, Galvanized Steel, Chemical Ground Rods, Electrodes, Plates, Clamps and Clamp Accessories.

Ground Mats and Mesh
Prefabricated solutions that are high quality, cost effective and safe - essential for reducing step potentials at power plants and substations.

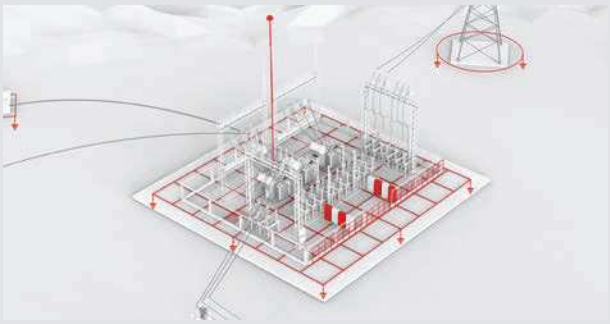


Ground Enhancement Material
Innovative solutions to improve conductivity in unfavorable soil conditions.

ENGINEERING SUPPORT

nVent ERICO offers technical support and recommendations for grounding system design. The primary goal is to establish a conductive reference to earth, which;

- Provides an electrical connection to earth plane
- Allows protection devices to operate
- Keeps system and structures at the potential of the earth (~zero)
- Lightning energy and ground faults
- Reduces step and touch potential to a tolerable level



nVent ERICO Grounding System Compliance Standards

- IEEE Std 80: Guide for Safety in Substation Grounding
- IEEE Std 837: Standard for Qualifying Permanent Connections Used in Substation Grounding
- IEEE Std 998: Guide for Direct Lightning Stroke Shielding of Substations

nVent ERICO Capabilities

Grounding and Bonding

nVent ERICO helped design the grounding and bonding system components that have become standard for substations in the utility industry.

We remain committed to our customers to help them overcome technical challenges and achieve a robust, reliable grounding and bonding system.

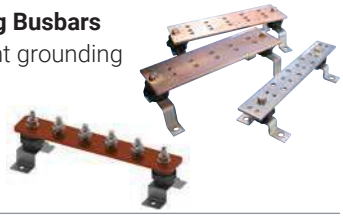
CONNECTORS AND GROUND PLATE

nVent ERICO offers a comprehensive line of connectors, ground plates and hardware, including:

nVent ERICO Copper Utility Pole Bottom Plate and our broader range of plate solutions provide efficient and effective termination. The ground conductor's in a utility pole-construction meets the requirements of the NESC®.

nVent ERICO Pre-fabricated Gate Jumper Assemblies are applied where Cadweld connections cannot be made to aluminum pipe or thin-wall steel tube.

nVent ERICO Utilities Grounding Busbars provide a convenient, single-point grounding and bonding location.

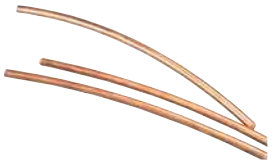


nVent ERICO Connectors include clamps and ground rods for Transformer Tanks, Vice Clamps, Fence Post Clamps, Rebar Clamps and Splice Bolts. Our offering includes various types of connections, including mechanical (bolted) and exothermic connections (nVent ERICO Cadweld).

CONDUCTORS

nVent ERICO conductors are feature-rich, proprietary connection solutions that are well-suited for specialized grounding and bonding applications. This product line is characterized by innovative material compositions that provide key advantages.

nVent ERICO Cu-Bond Round Conductor is a revolutionary ground conductor featuring a steel core with a copper-bonded surface. These properties improve performance and reduce cost.



nVent ERICO Cu-Bond Composite Theft Deterrent Cable is a bare concentric stranded conductor that consists of peripheral tinned copper-plated steel that protects and conceals the internal copper stranding. This conductor is ideal for exposed electrical grounding applications where copper theft may occur due to its tinned outer strands. The conductor is difficult to cut with hand tools, but the copper core makes it easier to install than other theft-deterrent conductors. The outer stranding is magnetic, which further deters thieves looking for copper. These conductors are ideal for transmission towers, distribution poles and a wide range of above and below-grade grounding applications.

nVent ERICO Capabilities

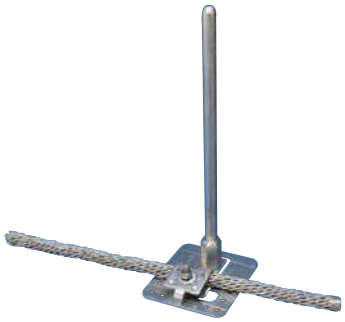
Lightning Protection for Utilities Infrastructure

Lightning is a major cause of power outages.

Direct and indirect lightning strikes to utilities infrastructure can also damage costly equipment.

nVent ERICO offers lightning protection (LP) solutions based on multiple types of LP methodology and standard of compliance. This allows us to provide LP solutions that are best suited to meet the needs of a given application area. While it's impossible to eliminate the risk of a lightning strike, nVent ERICO LP solutions provide the technology to avoid or mitigate damage to critical assets.

nVent ERICO System 1000
NF C 17-102
(Active ESE System)



nVent ERICO System 2000
Rolling Sphere Method
(Passive System)

nVent ERICO System 3000
Collection Volume Method
(Active System)

LIGHTNING PROTECTION DESIGN SOFTWARE

The placement of air terminals in a lightning protection system is critical for optimal protection. Our dedicated teams of nVent ERICO engineers are available around the world to provide support for all major lightning protection standards. We us advanced lightning protection system design software to model conditions and recommend equipment placement. This software enables us to provide our customers with:

- Increased velocity and reduced design lead-time
- Conventional and active system design
- Complete submittal package, including drawings, BOM, component cut sheets and risk assessment
- Capable of accepting and returning 3D project models in AutoDesk Revit and SketchUp compatible formats

nVent ERICO Capabilities

Surge Protective Devices

nVent ERICO is a leader in Surge Protective Devices (SPD) solutions that protect critical assets across a range of industries, including electrical utilities. We offer surge protection solutions that protect critical electronic equipment and systems in every application area, including power distribution panels, discrete signals (inputs and outputs), network communication data lines and RF signal equipment. This comprehensive offering includes standard surge suppression technologies (MOV, TOV, GDT, Spark Gap and hybrids) as well a proprietary nVent ERICO Transient Discriminating (TD) Technology that provides enhanced protection during extreme surge overvoltage events.

Technology advancements in the utility industry, including Smart Grid, Micro Grids, Battery Storage and IoT, has increased the demand for SPDs. Control and communication systems contain especially sensitive electronics that have a low tolerance for transient overvoltages. nVent ERICO SPDs provide essential protection for critical assets throughout the electrical utilities environment including:

- Substation SCADA Protection
- DIN Rail Surge Protection for the Smart Grid
- Premises and Meter Surge Protection
- SPDs for Data/Telecoms/Signaling Systems

POWER DISTRIBUTION PROTECTION

- (Left) nVent ERICO TDX Modular Series Panel Mount
- (Right) nVent ERICO DT/ EDT/PVT Series DIN rai power Surge Protective Devices

DISCRETE SIGNALS (INPUTS AND OUTPUTS)

- nVent ERICO UTB Universal Transient Series
  - 10kA per wire
  - 4 wires/package
  - 5V, 15V, 30V, 60V and 110V
  - Compact design

SERIAL COMMUNICATIONS, DATA NETWORKS AND RF

- (Left) nVent ERICO CSP Series 20kA-rated SPD for protecting radio/cellular antenna, camera, TV/Cable and BNC communications equipment
- (Right) nVent ERICO LAN Series for protecting Cat 5/5E, Cat 6 and PoE

nVent ERICO Six-Point Plan of Protection

The nVent ERICO Six-Point Plan of Protection is a system that provides comprehensive electrical protection for infrastructure and assets by integrating solutions for lightning protection, grounding and bonding, and surge protection. By making and distributing everything under one brand, you can be sure you'll have what you need for any facility, application or special consideration.

1. **Capture the lightning strike**. Attract lightning to a known and preferred attachment point using a purpose- designed air terminal system.
2. **Convey the energy to the ground**. Conduct the energy to the ground via a purposely designed downconductor system.

nVent ERICO LP solutions perform six-point plan tenets 1 and 2

3. **Dissipate the energy** into a low impedance grounding system.
4. **Bond all points together** to create an equipotential plane.

nVent ERICO Grounding and Bonding Solutions perform six-point plan tenets 3 and 4

5. **Protect incoming AC power feeders.** Protect equipment from surges and transients on incoming power lines to prevent equipment damage and costly operational downtime.
6. **Protect low voltage data/telecommunications circuits.** Protect equipment from surges and transients on incoming telecommunications and signal lines to prevent equipment damage and costly operational downtime.

nVent ERICO Surge Protective Devices (SPD) solutions perform six-point plan tenets 5 and 6

nVent ERICO offers products and solutions that perform the critical functions of each of these six tenants. When used in combination, nVent ERICO products seamlessly integrate to work in conjunction. While it's not possible to totally eliminate the risks of lightning strikes or power surges, the nVent ERICO Six-Point Plan of Protection approach provides our customers with the best opportunity to avoid or mitigate electrical damage.

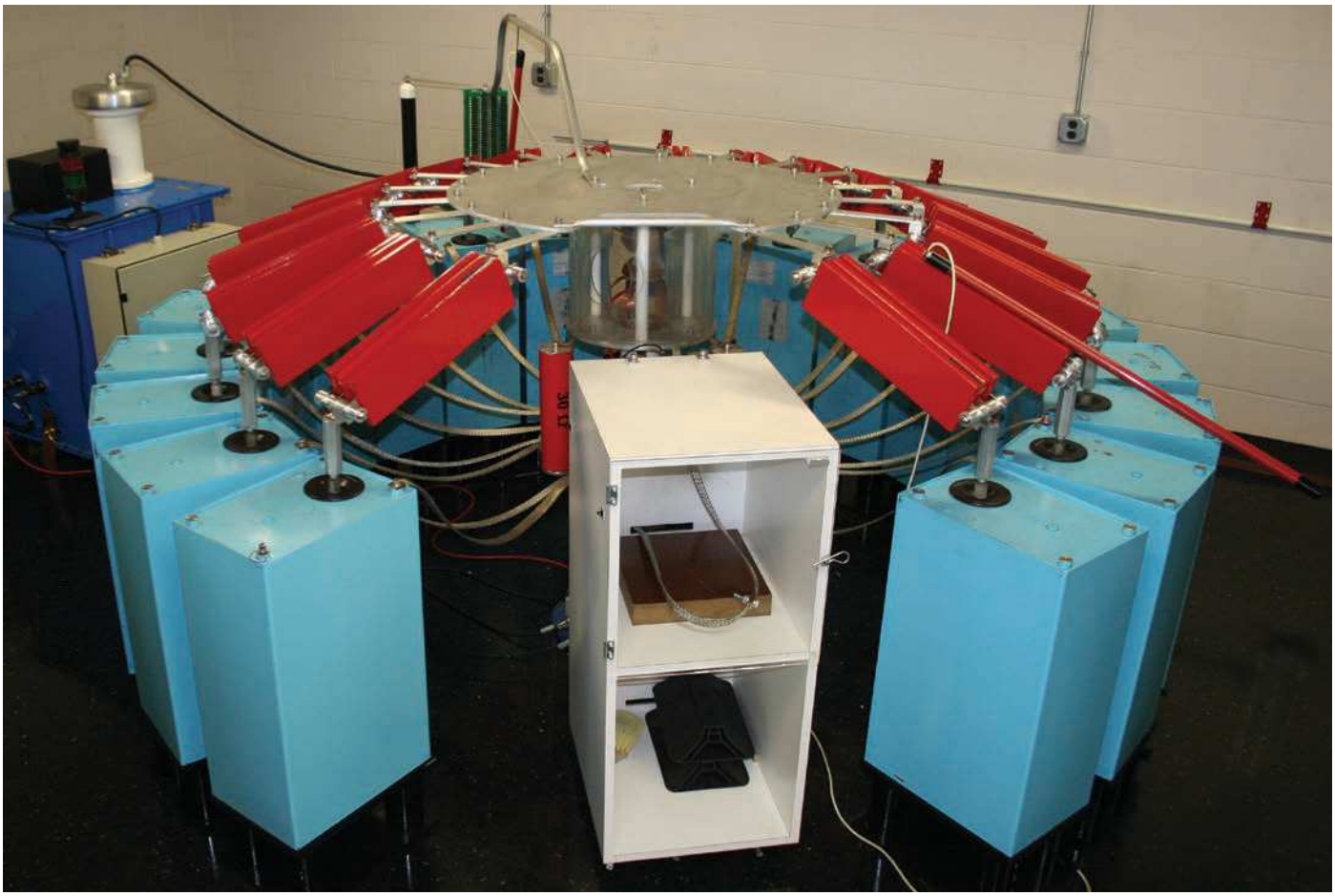
Engineering Support

nVent ERICO has a established a legacy of industry collaboration and new product innovation through our investment in in-house engineering resources.

Today, nVent ERICO offers technical support and design recommendations, supporting customers throughout the world with in-house engineering teams and cutting-edge resources. Our knowledgeable engineers are industry-leading experts who've spent careers specializing in niche electrical applications and can assist facility owners, engineers and contractors in designing the most appropriate electrical protection solution.

STATE-OF-THE-ART ENGINEERING ELECTRICAL LAB

To more effectively meet our customers' requirements, nVent ERICO has invested in state-of-the- art equipment and expanded the in-house Engineering Electrical Lab. By increasing capability, nVent ERICO can support major development and commercial opportunities. These tools are used in the development and testing of new products. We also invite our customers to use this as a resource, including side-by-side trials of nVent ERICO products vs. their existing solutions.



Applicable International Standards for the Design of Earthing/Grounding Systems

USA, AUSTRALIA, ASIA

- The IEEE® earthing/grounding and lightning protection standards in the U.S. are used quite commonly around the world, especially in Asia and Australia.
- The IEEE 80 Standard for Safety in AC Substation Grounding is the most common document used to assist with the design of a system. Many countries have guides written either by power utilities or industry associations to complement IEEE standards. IEEE 80 requires connections that are used in substations to pass all the tests stipulated in IEEE 837 as verified by independent reports.
- Cadweld welded connections have been shown to pass all of the test sequences in IEEE 837 in comprehensive tests carried out by independent test labs. In the same set of experiments, it was demonstrated that mechanical connectors that are sometimes used in substation applications do not pass the tests outlined in IEEE 837.
- Other standards relevant to grounding and lightning protection include IEEE 81, the Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Ground System and IEEE 998, the Guide for Direct Lightning Strike Shielding of Substations.
- The UL© 467 Grounding and Bonding Equipment standard provides a comprehensive compliance and testing method to ensure the long and reliable life of an earth/ground rod.
- In Australia, Standard AS 2067 provides requirements for the design and erection of high voltage installations in systems with nominal voltages above 1 kV a.c. and nominal frequency up to and including 60 Hz to provide safety and proper functioning for the intended use. This standard covers facilities owned by power utilities and consumer electrical installations. The key difference between this and other standards is that target resistance is not the key guiding principle of the grounding system design. This standard takes a risk-based approach. It states that the risk in terms of the safety of people should be 'negligible' or 'tolerable.' If the risk is classed as 'tolerable' then it shall be acceptable as long as all reasonable measures are taken to reduce the risk. This standard requires that joints used to assemble ground rods should have the same mechanical strength as the rods themselves and should withstand mechanical stresses during assembly. The conductors and the connectors, thermal ratings should be enough to withstand maximum ground fault for back up protection to work, and connection methods should meet the provision of standards like IEEE 80. To prevent theft and vandalism, consideration needs to be given to protecting exposed components and selecting alternative materials.
- We help our customers select nVent ERICO products that will meet the standards required for a given application.

EUROPE

- Most major power utilities in Europe have their own internal standards and regulations for the grounding of substations, and the designer should refer to them for guidance. Additionally, IEEE 80 (as well as the standards related to it) is also widely used as it provides a fully integrated approach to the design of an efficient earthing system. Standard IEC® 60479-1 contains a formula for the calculation of step-and-touch potentials but does not cover all of the resistivity, system resistance aspects or fault current-related calculations covered in IEEE 80.

Applicable International Standards for the Design of Earthing/Grounding Systems

LATIN AMERICA

- In Mexico, the utility [COMISIÓN FEDERAL DE ELECTRICIDAD (CFE)] uses IEEE 80 and IEEE 837 (rev 2002) in its project specifications. For ground rods, the utility also has its own specification, the 56100-16 (rev 2008). The rods must be issued by LAPEM (CFE Laboratory) during routine tests, which verifies compliance with CFE Specification 56100-16.
- With regard to lightning protection, Mexico uses ANCE NMX-J-549-ANCE-2005 Protection Against Lightning – Specifications, Materials and Methods of Measurement. Mexican law also establishes that all government entities must use the Mexican standards (called Norma Mexicana or NMX) or the official ones (Norma Oficial Mexicana or the NOM).
- In the rest of Latin America, the utilities adopt U.S. Standards (NFPA®, IEEE, NEMA®, TIA©/EIA©) and write local standards or local electrical codes based on these. Frequently, they will make minor modifications.
- Brazil uses low-voltage 127 V, and medium-voltage distribution 13.8 kV, 25 kV.

TRAINING

Free Learning Opportunities From Our Industry Experts.
nVent ERICO Training Courses teach participants a theoretical and practical understanding of protection designs and best practices for grounding, bonding, surge and lightning protection. We offer a dedicated training series covering electrical utilities infrastructure, with a wide range of courses on electrical protection for power generation stations (traditional and renewable energy), substations, power transmission structures, and power distribution poles.

Register Now www.nVent.com/efs-webinars

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