

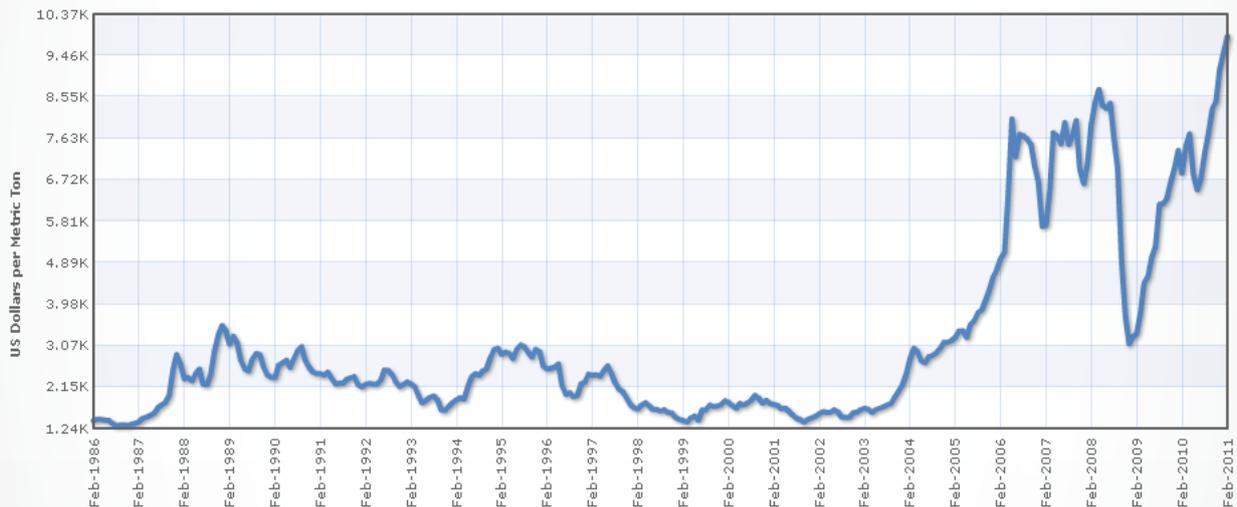


# AUSTENITIC STAINLESS STEEL GROUNDING SYSTEM 101

**Stavol**<sup>®</sup>

# WHY STAINLESS STEEL HARD FACTS

Out of the IEEE 80 list of materials that can be used for grounding systems it is widely known for years that copper and stainless steel have been preferred materials of choice for many different reasons. Unfortunately as the graph shows copper prices skyrocketed for the last 20 years making it a valuable commodity and fueling the problem is copper's high value on the scrap metal market. A pound of certain grades of copper can fetch almost \$3 a pound. A large box of copper loaded on a pallet can be worth \$6,000.



Theft has become a huge problem for many utility companies and the leaving any part of the distribution network without proper grounding leaves the system with devastating consequences. It is of no use to have the best and most expensive surge arresters if the down ground is completely lost or in bad conditions due to the galvanic corrosion so common in steel component installations.

Use of stainless steel was considered prohibited since commodity price differences were steep. Not anymore. Comparing dollar to dollar investment of old jacketed systems against solid SS is not what it used to be anymore.

Here is our proposal.

# IS YOUR SA REALLY ADAPTED TO ALL KINDS OF WEATHER CONDITIONS ?

**GALVANIC PAIR** ❌



**ZERO GALVANIC PAIR** ✅



A grounding or bonding device shall be constructed of a metal or metals that, when the device is installed under conditions of actual service and exposed to moisture, will not be likely to be adversely affected by electrolysis. The device shall have adequate strength and rigidity to permit its installation in the intended manner without rupture or distortion that would adversely affect the service of the device or damage the ground electrode or equipment to which it is attached.

Corrosion of metallic structures may be aggravated by any large galvanic couple of bare dissimilar metals. Such galvanic couples are set up by an extensive grounding system of bare copper cable and copper-clad ground rods interacting with iron or steel piping and conduits.

As part of Arrester Design and Manufacturing It has also been a practice in fabrication to use stainless steel components in the conduction path, with no effect on performance. It is safe to say that every modern station class arrester has stainless steel connectors making it the material of choice for long life and reliable service.

## EYES WIDE SHUT

**NOT COMPATIBLE WITH  
ALL KINDS OF SOILS**



**COMPATIBLE  
+ LONG LIFE**



VS

Since 1966 when the Navy did a study on ground rod metals as a result of a three year test it was determined that stainless steel was the material of choice. (Technical note N-853).

**It reads:** Extensive buried grounding networks are required to establish ground planes for radar installations and radio stations. These networks also serve as grounds for stray currents that would otherwise decrease the efficiency of these facilities.

The metal most commonly used for grounding networks at these and other facilities (such as power transformer stations) is bare copper as a solid rod or wire, or as a coating or cladding on a stronger base metal. A serious problem arises when extensive amounts of copper are buried in proximity to a less noble (less corrosion-resistant) metal: corrosion of the less noble metal is accelerated and the second metal eventually fails to perform its primary function.

# LIFE SHOULD BE SIMPLE!

**EXOTHERMIC WELDING** ❌



**BOLTED JOINTS** ✅



For many years there's been a debate about the quality of bolted connectors used for electrical purposes. Understandably so since most of the times the discussion gravitates around non ferrous materials and their lack of corrosion resistant properties when buried. Galvanic corrosion presents a huge challenge to overcome therefore the exothermic welding joints have become extremely popular among electricians and people of the trade.

Not so fast. there is an alternate solution to the problem by using approved 304 type stainless steel. Stainless steel connectors are not completely rare for grounding applications. Many customers in Germany have used them for many years with an impeccable record and not just for corrosive environments.

Our Mechanical connections come in two styles:

- The device captures the conductor within the connector and holds the surface of the connector against the structure by means of a bolt.
- The device holds the conductor against the structure with a clamping mechanism.

The choice is yours.

# GKS

## Austenitic Stainless Steel Type 304



1. Downspout Conductor
2. "C" Type Connector
3. Transformer Housing Conductor
4. Grounding Bar Bolted Connector
5. (4)  $\frac{3}{8}$  Premade Straps

All of the necessary elements are combined and put together as form of a kit in a simple box holding up tons of knowledge and experience. The using of just one same metal compatible 100% with the surge arresters makes it more suitable for not just corrosive environments but an excellent solution for the many cases of losing of grounding bonding due to galvanic pair with other materials.

### Metal Combination Examples

The Statue of Liberty (completed in 1886) is one of the highest profile examples of the damage that galvanic corrosion can cause. The original design used a copper exterior skin (large cathodic or noble surface area) supported by a cast iron structural frame (small anodic or active surface area) with the metals separated by wool felt which eventually failed. In 1984, it was closed to the public due to significant corrosion of the cast iron frame. It was rebuilt using a duplex stainless steel structural frame. Copper alloys and stainless steels are quite close in the galvanic series with the duplex being more cathodic which is appropriate since it has the smaller surface area ratio.

When multiple metals must be combined in direct contact and an electrolyte is likely to be present, the fasteners should always be specified to match the most noble of the metals being joined.

# SPECS CHART

TECHNICAL SPECS GROUNDING SYSTEMS FOR T&D TRANSFORMERS AND SURGE (ARRESTERS)			MANUFACTURERS WARRANTY
<b>1</b>	<b>Manufacturer</b>		<b>PGP</b>
<b>2</b>	<b>Components list</b>		
	<b>Down ground 36" x 7/8" x 0.047"</b>	YES/NO	YES
	<b>WEIGHT</b>	Grams	2,300
	<b>Down ground Three Phase 3,28" x 7/8" x 0.047"</b>	YES/NO	YES
	<b>C Type Connector</b>	YES/NO	YES
	<b>J Type Connector</b>	YES/NO	YES
	AISI-304 Stainless Steel Material	YES/NO	YES
	Section		RECTANGULAR
	<b>Rounded Corners</b>	YES/NO	YES
	<b>Clamps or Fastener Elements to the Pole</b>		
	AISI-304 Stainless Steel Material	YES/NO	YES
	Rectangular section: 9.5 mm x 0.7 mm x 1.500 mm	YES/NO	YES
	<b>U Type Connector to the Grounding System Electrode</b>	YES/NO	YES
	<b>Grounding System Electrode</b>		
AISI 304 Stainless Steel Rod Type of 8 feet	YES/NO	YES	

<b>Certificates</b>			
<b>3</b>	<b>Quality Management System Certificate</b>	YES/NO	YES
<b>4</b>	<b>Chemical Properties: Nominal Composition</b>	YES/NO	YES
	MAX. CARBON C: 0.08	YES/NO	YES
	MAX. MANGANESE Mg: 2	YES/NO	YES
	MAX. PHOSPHORUS P: 0.045	YES/NO	YES
	MAX. SULFUR S: 0.03	YES/NO	YES
	MAX. SILICON Si: 0.075	YES/NO	YES
	MAX. CHROMIUM Cr: 18.00 - 20.00	YES/NO	YES
	MAX. NICKEL Ni: 8.00 - 10.50	YES/NO	YES
	MAX. OF OTHER ELEMENTS N: 0.10	YES/NO	YES
	CORROSION SALT SPRAY TEST	YES/NO	YES

<b>Electrical Properties</b>			
<b>5</b>	Short Circuit Intensity 0.1 Seconds	kA	5.5
	Impulse Test at 8/20 Microseconds	kA	20
	Permanent Nominal Intensity Test	A	40
	<b>CONNECTOR CURRENT TEST</b>	A	2450
	<b>Provides Test Protocol</b>	YES/NO	<b>YES</b>
	<b>Step &amp; touch potential Test</b>	YES/NO	<b>YES</b>
	<b>Physical Properties</b>		
<b>6</b>	Exothermic Welding	YES/NO	NO
	Complete Connection Without Exothermic Welding, or Interstitial Spaces	YES/NO	YES

# STEP AND TOUCH POTENTIAL

## DEFINITIONS

**STEP potential:** It is the potential difference that occurs during a fault, between two points with a distance of approximately one meter (3.28 feet).

**TOUCH potential:** It is the potential difference that occurs during a fault between a metal structure and a person who has contact with the structure that is normally de-energized.

## TOOLS AND EQUIPMENT



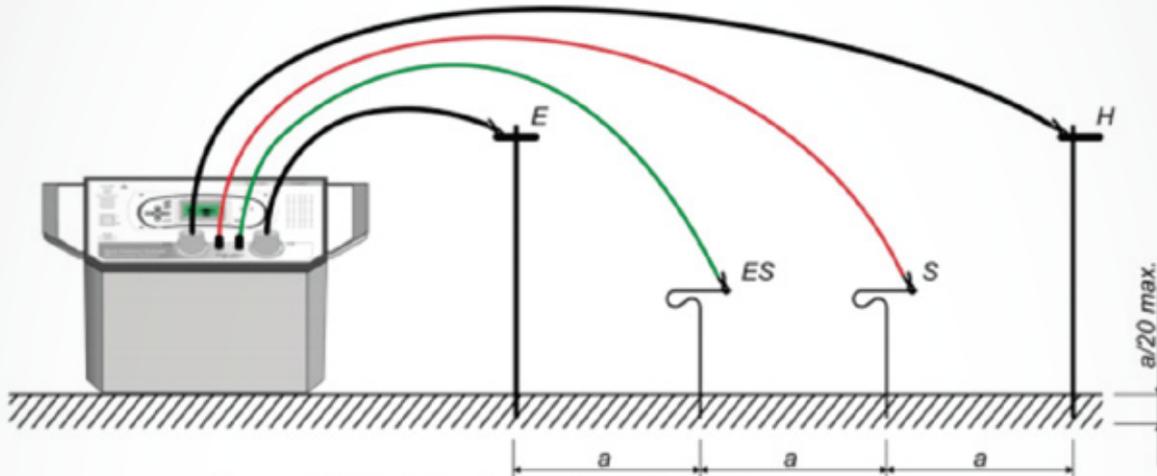
EQUIPMENT USED FOR STEP & TOUCH POTENTIAL  
METREL MI 3295.

## RESISTIVITY OF THE TERRAIN:

The field resistivity was measured using the equipment MI 3295s, and the results were as follows:

ITEM	TERRAIN RESISTIVITY		GROUND $R_c$ [k $\Omega$ ]	GROUND $R_c$ [k $\Omega$ ]	GROUND $\rho$ [ $\Omega$ ]	GROUND DIST.
1	LOCATION 1 TO 17	3/31/2017	414	374	37	3.28 FEET

This measurement was performed as indicated in the manual of the MI 3295s Figure 3, taken as distance of 1 meter.



### MEASUREMENT OF STEP AND TOUCH POTENTIAL

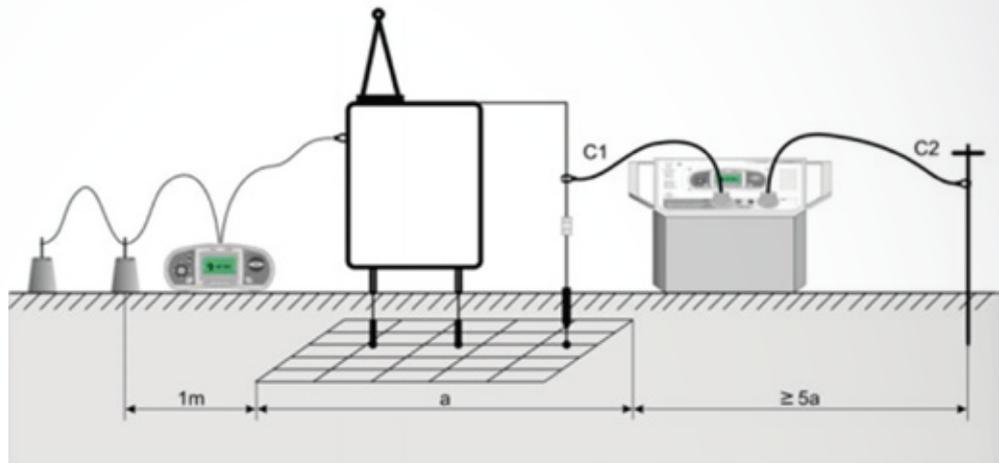
To carry out these measurements, a 304 stainless steel electrode of 5/8" diameter and 8 feet long was installed at a distance of 1.3 feet from the metal pole. This system was subjected to step and touch voltage measurements, using two different systems, which are specified below:

- 1. Components:** Parallel plates made out of type 304 stainless steel, downstream conductor 7/8" wide by .047" thick and connector type U all of it using type 304 stainless steel.



### TOUCH POTENTIAL

**PROCEDURE:**  
 For the touch potential measurement, the assembly shown in figure 7, connecting the output C1 to the earthing system, C2 to the auxiliary electrode located at 72 feet and connecting the voltmeter in series to pole with the parallel plates at a distance of 3.28 feet.



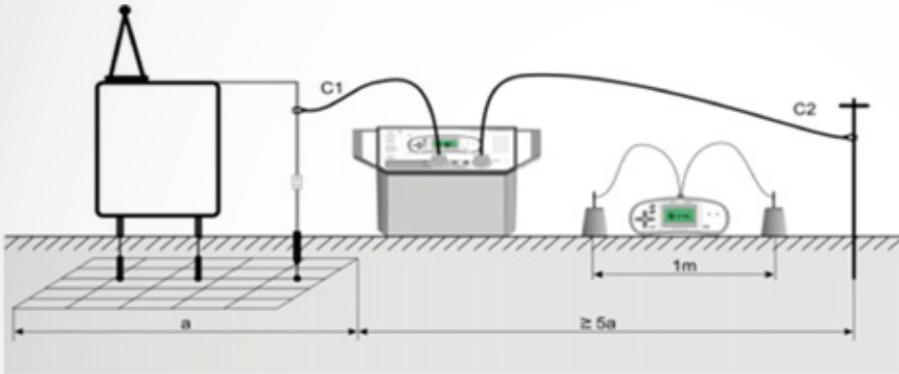
The measurements recorded for system 1 (parallel plates) were as follows:

TOUCH POTENTIAL OVER PARALLEL PLATES # 1									
LEAD LENGTH 3.28 FEET			TOUCH POTENTIAL						
ITEM	LOCATION	DATE	Vcon.[V]	U cont. [mV]	Iset [A]	Igen [A]	Ifault [KA]	Re[kΩ]	Vlimit[V]
1	1	3/31/2017	0,5	0,05	0,6	0,51	5	1	50
2	2	3/31/2017	0,4	0,04	0,6	0,51	5	1	50
3	3	3/31/2017	0,4	0,04	0,6	0,51	5	1	50
4	4	3/31/2017	0,4	0,04	0,6	0,51	5	1	50

The measurements recorded for System # 2 were as follows:

TOUCH POTENTIAL OVER TYPE U CONNECTOR # 2									
LEAD LENGTH 3.28 FEET			TOUCH POTENTIAL						
ITEM	LOCATION	DATE	Vcon.[V]	U cont. [mV]	Iset [A]	Igen [A]	Ifault [KA]	Re[kΩ]	Vlimit[V]
1	9	3/31/2017	0,3	0,03	0,51	0,51	5	1	50
2	10	3/31/2017	0,4	0,04	0,51	0,51	5	1	50
3	11	3/31/2017	0,2	0,02	0,51	0,51	5	1	50
4	12	3/31/2017	0,4	0,04	0,51	0,51	5	1	50

### STEP POTENTIAL



**PROCEDURE:** For the step potential, the assembly indicated by the user manual Figure 12, connecting the output C1 to the earthing system, C2 to the auxiliary electrode at a distance of 72 feet, and at a distance of separation of the voltmeter to the earthing system of 3.28 feet.

The measurements recorded for system # 1 were as follows:

STEP POTENTIAL OVER PARALLEL PLATES # 1									
LEAD LENGTH 3.28 FEET			TOUCH POTENTIAL						
ITEM	LOCATION	DATE	Vcon.[V]	U cont. [mV]	Iset [A]	Igen [A]	Ifault [KA]	Re[kΩ]	Vlimit[V]
5	5	3/31/2017	0,7	0,08	0,6	0,51	5	1	50
6	6	3/31/2017	0,3	0,03	0,6	0,51	5	1	50
7	7	3/31/2017	0,5	0,06	0,6	0,51	5	1	50
8	8	3/31/2017	0,7	0,07	0,5	0,51	5	1	50

The measurements recorded for System # 2 were as follows:

STEP POTENTIAL OVER TYPE U CONNECTOR # 2									
LEAD LENGTH 3.28 FEET			TOUCH POTENTIAL						
ITEM	LOCATION	DATE	Vcon.[V]	U cont. [mV]	Iset [A]	Igen [A]	Ifault [KA]	Re[kΩ]	Vlimit[V]
5	13	3/31/2017	0,3	0,03	0,51	0,51	5	1	50
6	14	3/31/2017	0,3	0,03	0,5	0,51	5	1	50
7	15	3/31/2017	0,3	0,03	0,5	0,51	5	1	50
8	16	3/31/2017	0,3	0,03	0,5	0,51	5	1	50

**Conclusions:** As showed on the results above, it is safe to say that one of the most important aspects of the grounding systems is accomplished here. Debunking the myth that Stainless Steel is price prohibited is one of our most important responsibilities since the reliability and level of protection is unquestionable. Stainless steel is a man made material that has been perfected and made available for the last 40 years. Let's put to good use this incredible material on one of the areas that sustains the most requirements of our T&D network.



## GKS INSTALLATION BY CODENSA IN COLOMBIA



Life should be simple!





## GKS INSTALLATION IN ECUADOR





## GKS INSTALLATION IN BOLIVIA



# COLOMBIAN COPPER EXPORTS



COMTRADE | TRADINGECONOMICS.COM

## ABOUT THE ENEL GROUP CODENSA AND EMGESA

CODENSA and EMGESA are part of the Enel Group, a multinational energy company and one of the main global integrated operators in the electricity and gas sector. The Group operates in more than 30 countries from four continents, generating energy through an installed net capacity of around 83 GW and distributing electricity and gas to a network of around 2 million kilometers.

With more than 65 million users in the world, the Enel Group has the largest customer base compared to its European competitors. The Enel Group is the biggest integrated utility company in Europe in terms of market capitalization, and it is one of the main electricity companies in Europe in terms of installed capacity and reported EBITDA.

Codensa S.A. E.S.P. is a distribution and electric energy sales company, as well as a leader on the market, with more than 3,200,000 clients distributed in Bogotá, 116 municipalities of Cundinamarca, 6 in Boyacá, 4 in Tolima and 3 in Meta. Established in 1997, CODENSA has an installed capacity of 10,633 MVA (mega-volt amperes) along 69,821 kilometers of high, medium and low voltage networks. The Company generates around 14,000 jobs both directly and indirectly in Colombia.

Supplying continuous, reliable energy to every corner of Bogota and to over 100 municipalities around the Department of Cundinamarca in an efficient manner is more than just part of our corporate vision – it is our *raison d'être*.

With a 24% share in the country, Codensa is the leader in the Colombian market with more than 3 million customers. Furthermore, it has become an international benchmark within Enel Group companies worldwide due to its excellent operational management. Our company has over 120 electrical substations, installations that modify and establish voltage levels, and over 71,358 kilometers of medium and low voltage grids serving Bogota and the neighboring rural areas of Cundinamarca – a robust grid designed to sustain Codensa's top ranking.

However, although there is a drop in energy demand, projects to expand our capacity to adequately meet demand growth continue to advance significantly:

- > We continue with the construction of the Nueva Esperanza Substation 500/115kV and associated lines: At the end of 2016 the civil and electromechanical construction phase was completed and the testing and commissioning phase is in progress
- > During 2016, we followed up on the environmental licensing process of the Norte Substation, the acquisition of power equipment and the detailed engineering of the substation and transmission lines.
- > We acquired a Mobile Substation of 40 MVA, load-adjustable and four mobile MT cell trains, an infrastructure that will allow us to develop new modernisation and expansion projects, without affecting quality supply to our customers.

## Operating Environment: A world-class company with significant improvements in the main technical indicators

During 2016, we accomplished significant achievements in projects and activities to improve service quality, which resulted in our customers having -19% improvement in the average interruption frequency (8.83 times SAIFI – System Average Interruption Frequency Index) and -18% in interruption duration (68763 Min of SAIDI -System Average Interruption Duration Index-).

The work fronts focused on:

- > Network Telecontrol Project
- > Redesign and replacement of medium voltage networks
- > Normalisation of high voltage networks
- > Modernisation of essential services in HV/MV substations
- > Forest management
- > Plan of action to control and/or mitigate the impact of rainy and windy seasons
- > Protection management
- > Modernisation of communications substations

The results described above correspond to our vision of managing the network to achieve global standards in service quality, under scenarios of greater investment and operations, implementing the Telecontrol to our network and complying with the Regulatory Quality indicators (we estimate an Grouped Annual Index of Discontinuity from – IAAD of 1.14% for Level 1, and -5.3% for Grouped Level 2 and 3), thus achieving very satisfactory Quality of Service indicators for all our customers.

In addition, and continuing our market discipline programme, we achieved a loss index of 7.06% at the 2016 year-end closing, lower than the 7.14% of the previous period, leading to a significant decrease in energy losses 2016 (1,045 GWh) compared to 2015 (1,086 GWh). All thanks to the implementation of plans to reduce energy theft, focused on 5 aspects: strategy and planning, control and follow up, monitoring and support, normalisation of peripheral areas, and technical losses.

## Who we are

POWER GRID PROS, is a newly formed company completely focused on manufacturing and consulting in the areas of grid protection systems. Our team combines the experience of several engineers in the field of T&D. We also have many completed installations throughout South America where the problem of copper theft is pandemic.

There are more than 600,000 transformer distribution systems already installed and tested for more than 9 years. We would like to offer the same advantages of proven markets in the USA for a product line that has a pristine record of reliability and support.

Let us help you with an alternative in grounding systems, with the knowledge and professionalism that characterizes us and made us the number #1 Grounding Systems supplier for many utility companies around the world.

Contact us with your specific request for a kit that can be customized according to your needs. We have helped different areas of Telecommunications, Structural and Building Grounding compliance and many others.

**References:**

- ANSI / NEMA GR1 - 2007
- US NAVY TECHNICAL NOTE N - 853 / 1966
- IEEE 80
- ASTM 240
- UL 486A
- NEC

**How good could your surge protection be without proper grounding?**



## **GKS** - Austenitic Stainless Steel Type 304

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**Stavol**<sup>®</sup>



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