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Electrical Surge Protection Device (SPD): An Alternative to Reduce Material Loss

Jorge Elson Pimentel Nascimento;Fabiana Rocha Pinto;David Barbosa de Alencar;Gisele de Freitas Lopes

Abstract

The SPD is undoubtedly the equipment designed to protect the electronics of any building, one of the protections that together with proper grounding and SPDA, are widely used by industry to protect their equipment and people. This research shows the importance of SPD for electrical installations in general, shows that we still do not have the risk of encircling all electrical protections in our homes, which lead to inquiring. Why not use all safety measures in our residential electrical installations, viewed as people who build a bus camera rated by a qualified professional, to guide their client, explaining to him the importance of a safe installation, ie the values with electrical material are still elevated for safe construction. In this research, some brands of SPD were analyzed and compared as to the method of manufacture, classification and prices, a survey that also did not comply with Law No. 11,337, of July 26, 2006. Determines the obligation that the buildings have a system grounding and electrical installations used with the use of conductor protective earth, as well as making the presence of conductor protective earth mandatory in the electrical appliances it specifies. Law 12,119 / 09, of December 15, 2009, amends art. 2 of Law No. 11,337, of July 26, 2006, to better detail the scope of its content and to adapt the nomenclature used to the technical standards used. "Art. 2 Electrical and electronic equipment, with metal housing marketed in the Country, classified in class I, in accordance with the relevant national technical standards, the items allowed for use in earth protection and with plugs, are also allowed in accordance with Brazilian technical standards.

Keyword: Electrical surge protection device, grounding, cost-benefit;

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Jorge Elson Pimentel Nascimento
jorgeelsonn@gmail.com
FAMETRO University Center – Brazil

Fabiana Rocha Pinto
fabiana.floresta@gmail.com
Engineering Coordination at FAMETRO University Center – Brazil

David Barbosa de Alencar
david002870@hotmail.com
Galileo Institute of Technology and Education of the Amazon – ITEGAM

Gisele de Freitas Lopes
gikalps@gmail.com
Galileo Institute of Technology and Education of the Amazon – ITEGAM

Abstract

The SPD is undoubtedly the equipment designed to protect the electronics of any building, one of the protections that together with proper grounding and SPDA, are widely used by industry to protect their equipment and people. This research shows the importance of SPD for electrical installations in general, shows that we still do not have the risk of encircling all electrical protections in our homes, which lead to inquiring. Why not use all safety measures in our residential electrical installations, viewed as people who build a bus camera rated by a qualified professional, to guide their client, explaining to him the importance of a safe installation, ie the values with electrical material are still elevated for safe construction. In this research, some brands of SPD were analyzed and compared as to the method of manufacture, classification and prices, a survey that also did not comply with Law No. 11,337, of July 26, 2006. Determines the obligation that the buildings have a system grounding and electrical installations used with the use of conductor protective earth, as well as making the presence of conductor protective earth mandatory in the electrical appliances it specifies. Law 12,119 / 09, of December 15, 2009, amends art. 2 of Law No. 11,337, of July 26, 2006, to better detail the scope of its content and to adapt the nomenclature used to the technical standards used. "Art. 2 Electrical and electronic equipment, with metal housing marketed in the Country, classified in class I, in accordance with the relevant national technical standards, the items allowed for use in earth protection and with plugs, are also allowed in accordance with Brazilian technical standards.

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1. Introduction

About 100 million lightning strikes every year in Brazil, so it is currently the country with the highest incidence of lightning in the world, causing huge damage to equipment and electronics [1]. Despite the protection of lightning rods, lightning strikes produce an electromagnetic field that radiates throughout the region as an indirect discharge of energy, especially over power and telecommunications networks.

According to a study by [2] the incidence of lightning across the country has increased, knowing that, studies show that the electrical surge can present high frequencies occurring for a short time. Outbreaks can be of voltage or current and can originate from lightning, electrostatic discharge and the switching of inductive or capacitive electrical charges.

Upon reaching a city's electricity distribution network, indirect discharge eventually causes a momentary increase in voltage, or transient overvoltage, which can cause irreparable damage to electro-electronic devices [3]. SPD offers a complete, high-performance solution against overvoltage driven by power lines, safely protecting electrical and electronic equipment.

SPD is highly recommended in all electrical installations, especially in regions where the incidence of lightning is very high. It can be installed in the electrical circuit diagrams with grounding systems in accordance with the main current regulations of the country.

This surge protection device protects your equipment against lightning burns. [4] defines SPD as: “Device designed to limit overvoltage’s and divert surge currents, contains at least one nonlinear component”. The same standard classifies SPD into two types: voltage switch and voltage limiter.

A SPD, ideal voltage switch, can be represented by a switch connected in parallel with the circuit or equipment to be protected. This switch is controlled by the voltage value at its terminals, where the voltage is below a certain limit, remains open. However, if the voltage reaches the limit, automatically closes, the specified limit for switch close (Up) must be less than the voltage value supported by the protected equipment (Uw). It is important to note that the continuous operating voltage (Uc) cannot cause the switch to close [5].

Lightning can damage electrical and electronic equipment in three ways.

The. direct: when lightning strikes a building and causes damage to both construction and equipment. The protection in this case occurs by lightning rod, Franklin type and / or Faraday cage; B. Indirect: When lightning strikes in the vicinity of a building, overload damages equipment via the power grid. Protection is provided by electrical grounding with SPD; ç. Electromagnetic interference: When lightning strikes a nearby building and generates electromagnetic waves capable of inducing dangerous voltages for any electronic equipment. The solution is SPD specific to each device.

Thus, the electrical surge is a transient wave of voltage, current or power that has a high rate of change over a very short period of time. It spreads throughout electrical systems and can cause serious damage to electronic equipment. Electrical surges are usually caused by lightning strikes, network maneuvers, and on / off of large machines.

Speaking of lightning strikes, whenever lightning strikes near a facility / power grid, surges are generated that can even reach appliances connected to power grids, data lines such as internet and cable TV and telephone lines. . Most lightning-generated outbreaks are caused by indirect discharges, that is, even if the

lightning strikes miles away, this incidence generates an electromagnetic field that radiates from the environment and transfers a portion of the ray to a metallic conductor.

Another very common source of electrical surges is when power companies switch or maneuver their grids, causing power outages in certain neighborhoods or streets. Not just blackouts, known as blackouts. Thus, reclosing attempts are sources of electromagnetic disturbances, including the electrical surge.

Electrical surges occur continuously when large motors start and stop. Outbreaks can be generated either by elevators in commercial and residential buildings or by standard equipment such as air conditioners or washing machines. Each time they are started and stopped, motors generate transient overvoltages that can cause immediate, medium and long term damage to equipment connected to the same power grid.

The SPD consists of a zinc oxide (ZnO) or silicon carbide (SiC) varistor associated with a safety device which can be one of the following components: gas spark arrester; air spark; avalanche diodes or suppressor diodes; varistors and PTC or thermistors.

The function of the varistor in a SPD is by continuously reducing the surge wave, while the spark is intended to cut the peak of the incident wave, rapidly reducing the voltage wave, protecting the varistor if it is subjected to a peak. greater than its rated capacity. When in normal operation, the SPD displays green and when damaged, red [6].

According to [7], SPD is a device designed to limit transient overvoltages (voltage attenuator or surge suppressor) or to divert surge currents (voltage switch or short circuit) [8].

[8] says that in order for the designer to properly analyze and compare products, manufacturers should provide the following SPD information: manufacturer's name or trademark and model; mounting method or protection mode, accompanied by the positioning sketch on the installation; maximum continuous operating voltage Uc, which is the nominal voltage of the SPD (one value for each protection mode), and nominal frequency; test classification (class I, II or III) and discharge parameters; maximum current Imax (KA), parameter of the wave on which the SPD was tested; Iimp pulse current (KA) and load Q (A.s), for SPD class I (value for each protection mode); rated discharge current In (KA) for SPD class II (value for each protection mode); Voltage protection level Up (value for each protection mode); withstand temporary overvoltages and withstand short-circuit currents at the point of installation.

1.2 Minimum Parameters

Minimum parameters to be included in the SPD nameplate data as well as design specifications: SPD Class I: Uc, Up, Imax, Iimp, Q and test T1 / T2 curve; Class II SPD: Uc, Up, Imax, In, Q and 'T1 / T2' test curve and Class III SPD: Uc, Up, Imax, In.

[9] used [7] to classify SPD at each level of protection. Establishing three types: Class I, intended for protection against overvoltage caused by lightning strikes on or near buildings; Class II, intended for overvoltages of atmospheric origin by indirect loads and Class III, intended for electro-electronic equipment.

CLASS I has a high surge exposure capability with a minimum of 12.5 KA of impulse current (Iimp) according to [9], item 6.3.5.2.4- “d”.

Thus, the classes have different applications as: Class I, it should be applied near the main entrance of the power grid and the main equipotentialization bus, BEP, in buildings equipped with lightning rods, as per

the requirement of [9] and next information technology (ETI) equipment, such as a secondary element fed directly into the primary cabin or switchboard, increasing reliability, lower residual voltage, and long life against overvoltages and transients caused by lightning strikes or power grid switching inductions [10].

CLASS II also acts against maneuvering overvoltages with a minimum surge exposure capacity of 5 KA rated current (In) according to [9], item 6.3.5.2.4- "d". It must also be applied near the main entrance of the power grid and the main equipotentialization bus "BEP", in buildings equipped with (I) or not (II) lightning arrester, as required by [9] or as a protective device. class II, in switchboards, with information technology (TSI) equipment, among others, against overvoltages and transients caused by lightning strikes and frequent switching inductions in the power grid [10].

CLASS III, is given by means of a fine protection, adjustment, providing a lower residual voltage and, consequently, an effective protection for the equipment, applied next to the information technology equipment (TSI) and others, with lower current consumption. at 10A, connection in series with the load.

The devices must be installed in a coordinated manner, producing a ripple effect, that is, firstly, the SPD with higher capacity of exposure to surges, then with medium capacity and, finally, the most sensitive SPD are installed [10].

[9], in item 5.4.2.1, establishes that all buildings within the Brazilian territory that are totally or partially fed by area line and where thunderstorms occur more than 25 days per year, must be provided with SPD. (zone of influence AQ3), SPD is also required.

There are suppressor protection elements applied in SPD to protect equipment connected to the power and signal network are:

The. spark plugs, are made up of two separate electrodes (GAP), dielectric Air or Gas. They have low conduction velocity (response time) and high current capacity; B. Air sparklers can be classified into two basic groups: open and encapsulated. Open sparklers are used as first-rate defenders when their drawbacks - fire hazards, disruptive voltage varying with weather, pollution, etc. They are without prejudice to the purpose of protection.

Old coal protectors fit this type and their discharge capacity is low; they are uneconomical and virtually no longer used. Encapsulated spark arrestors are also referred to as isolation or coupling spark arrestors and are used where two circuits cannot be permanently in contact but must be at the same potential when lightning is influenced [10]; ç. Gas cutters are constructed by two or three electrodes inside a glass or ceramic tube, separated by a well-defined distance, of the order of (one) mm, the volume being filled by a rare gas.

The breaking voltage will be determined by the distance between the electrodes and the gas pressure. Durability and the ability to withstand high currents is determined by the material of the electrodes, while the leakage current is given by the quality of the glass or ceramic material used.

When used in telephony, sparks must support the short current of a power line that falls over the telephone line. If the current is greater than that specified for driving or if the defect is not interrupted before the specified time, the spark arrester may be destroyed, with danger to telephone users.

To reduce this possibility, some spark arresters have a safety device at the terminals externally, increasing the current and the bearable duration. Air gap spark plugs are indicated for application in class I and are subject to environmental conditions, such as atmospheric pressure, relative humidity and temperature,

which thus differ (Table 1).

DISADVANTAGES	BENEFITS
Low protection margin for fast forward outbreaks.	It has a large current conduction capacity of tens of KA.
Usually short circuit to ground.	It has a long life.
It produces high frequency oscillations due to the sharp drop in voltage between the electrodes.	It has a very low capacitance, not interfering with the operation of high frequency circuits.

Table 1. Advantages and disadvantages of using spark arrestors.
Source: [3]

Suppressor diodes are high conduction speed semiconductors and low current capacity. They are applied as secondary protection elements in hybrid configurations and better known as solid state elements. The response time of a suppressor diode ranges from one (1) picosecond near the substrate to one (1) nanosecond at its terminals [10].

Varistors are resistors whose value of electrical resistance depends on voltage. Resistance is not constant, resulting in a nonlinear relationship between voltage and current.

Applied in class I, II and III, they feature high driving speed and good current capacity. The number of brands, types and origin is numerous, and the technical characteristics of current and voltage of this component vary from manufacturer to manufacturer with the same diameter and thickness [10].

As a general rule, the diameter of the varistor determines the withstand impulse current value, thickness, voltage and mass and power capacity.

PTC or Thermistors are temperature sensitive and overcurrent semiconductor polymers or resistors. Its resistance value increases rapidly when a certain temperature or current is exceeded, such as reversible fuses. Typical application is in the manufacture of hybrid protectors normally applied to signal networks.

Every electrical installation needs a grounding that ensures its perfect operation and also the safety of people and equipment. Several technical standards, as well as the NR-10 regulatory standard of the Ministry of Labor and Employment, require that all electrical installations be grounded. Having a good grounding is important in the case of lightning, given that the lightning current is injected and circulates in the ground [11].

Thus, there are different grounding applications, including houses with TN-C Systems, where the electrical installation of the vast majority of Brazilian homes does not comply with [9], which recommends the use of the TN-C grounding scheme. S with protective conductor (PE) and equalization bus. In most buildings there is only the neutral conductor, grounded at the entrance to the building.

Although not recommended, the current standard is possible, with some limitations, where SPD should be installed in these buildings and improve the protection of electronic equipment. Importantly, even though it is possible to install SPD in buildings without the protective conductor, it is ideal that the electrical installation be redone to meet the recommendations of the standard [9].

Primary SPD for power lines should be installed between phase and neutral, preferably at the installation source, with one required for each phase. Some utilities have already standardized the installation of SPD

inside the metering box.

According to [12], secondary circuit distribution boards (QDC) located more than 20 m from the power input or general distribution board (QDG) must also be equipped with Class II SPD.

Importantly, the choice of SPD nominal voltage (275 V for 220 / 127V systems) takes into account temporary overvoltages (caused for example by a neutral conductor disruption). At this rated voltage value, the SPD will not operate due to overvoltage caused by the neutral disruption.

In addition, for protection of equipment that meets the withstand levels of [9] (in this case, withstand voltage Uw = 1.5kV), the rated voltage SPD 275V ensures an adequate protection margin because the protective voltage of the SPD (Up = 1.2kV) is below the voltage withstand by the equipment.

If the possibility of neutral disruption is remote, a lower rated voltage SPD may be used. Under these conditions, a SPD with Uc = 175V could be used in 220 / 127V systems when connected between phase and neutral or phase and ground. The lower rated voltage SPD will have a lower residual voltage. However, if the neutral breaks, the SPD will be in permanent operation and the overcurrent protection system will actuate and remove the SPD from the circuit.

The previous reasoning for 220 / 127V grids also applies to 380 / 220V grids, provided that the relevant values of Uc and Uw are considered.

Primary SPD should preferably be installed at the installation source, both on power and telecommunications lines. The choice of class and level of protection should follow the criteria already discussed in the previous item.

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Secondary Circuit Distribution Boards (QDC) located more than 20 m from the source of the installation or the General Distribution Board (QDG) must also be protected with class II SPD. Appliances or electronic equipment located more than 10m from the QDG must also be protected by SPD Class III, such as refrigerator, dishwasher, microwave, among others.

Similar to the above, multi-input electronic equipment such as power and telecommunications should be protected by combined SPD. Examples of such equipment are televisions with connected signal input (eg coaxial cable), cable modem, ADSL / VDSL modem, cordless telephone, among others. It is worth mentioning that the local potential equalization performed by the SPD is fundamental to ensure the protection of this equipment. This combined SPD are also called Multiprotection SPD (SPDM) [5].

2. Materials and Methods

2.1 Type of study

The type of approach adopted in the research comes from the descriptive method, having as research sources the books, booklets, ABNT, NR and websites of companies that produce and market the SPD that served as the basis for knowledge and brings as a qualitative result the importance in continuous safety improvement in building electrical installations, because we must be concerned with all safety methods such as SPDA, grounding, DR's and SPD for safe building.

We sought to evaluate the types of SPD in the market, in terms of manufacturing method, classification and price, where it was found that practically all manufacturers use the same methods and classify their SPD in

the same way according to [4] and [9].

2.2 Data Collection

Data collection was done through bibliographic reference searches, to consult various books, booklets, ABNT, NR and websites of companies that produce and market the SPD that would help to base on the chosen theme, was also used. Information via web, consultation of scientific articles, monographs and NBR that helped me in understanding the topic addressed.

Siemens, Schneider, MTM and Clamper brands were compared, minimum parameters that must appear in the data on the SPD board. When choosing a SPD, many factors should be taken into account, such as where the device will be installed, in order to determine which class to use, and the key factors to determine, such as the maximum operating voltage of the device. device and its maximum discharge current.

3. Results and Discussion

When it comes to low voltage electrical installations, it is crucial to highlight the use of protective devices that ensure the integrity of the electronics of a home, while preserving the heritage of electricity users. The standards adopted by ABNT are advancing more and more, encouraging the use of SPD that increases the necessary security that is intended.

In this way, older installations lose their capacity and may pose potential risks, so it is mandatory to carry out appropriate renovations when they are convenient. By observing these recommendations, we can avoid numerous disorders that may cause unpleasant situations and irreparable losses.

Basically, we can say that the utility of the lightning arrester is the same as that of SPD, since they work as internal protection for homes. However, taking into account the functional aspect, we say that each protects the building differently. These devices constitute an SPDA (Lightning Protection System) regulated by technical standards [9], [4] and [13].

Looking at the cost-related financial issue, the lightning arrester system is costly to install, but it is recommended for buildings and industries, as well as places with essential equipment that must be preserved.

Finally, the results of this study showed us that practically all the protection devices available on the market are produced by the brands mentioned above are composed of equal components, the great differential between them is in the value added to each brand, where the company stood out. CLAMPER which is synonymous with protection for the market. It is your brand.

This achievement is the result of a relentless pursuit of excellence and improving people's lives. The company is today recognized by the market as a leader in research in development and manufacture of electrical surge protection devices (SPD) for the various segments of the national and international market. The SPD, installed in the power distribution box, which aims to protect the power grid. This gives Clamper VCL the best value for money.

We exemplify that in a medium size house, having as characteristic living room, kitchen, two bathrooms and three bedrooms. Have the following electronics: two units of LCD TVs that cost $ 2,500; a Blu-ray player that costs $ 400.00; a stereo that costs $ 500.00; a video game device that costs R $ 1,200.00; a home

theater device that costs R $ 700,00; a cordless handset that costs $ 200; a computer device that costs $ 1,500; a refrigerator that costs R $ 1,200.00; a washing machine that costs R $ 1,000.00; a stove that costs R $ 500,00; a microwave device that costs R $ 400,00; a grill that costs $ 200.00; an electric oven that costs R $ 500,00; two electric showers costing R $ 100.00 and ten compact fluorescent lamps that cost R $ 100.00, totaling R $ 11,000.00. All prices of items being estimated from average market values.

Many other home appliances are known to be present in homes of this type, but this estimate fits most homes.

This means a product of $ 49.00, being able to prevent a loss of about $ 11,000.00 in the event of a major electrical surge, with appliances cleared for damage caused by electrical discharge. The VCL can act hundreds of times without replacement. Therefore, it is more difficult to estimate the actual cost x benefit ratio. Even so, it can be said that it is a low investment for the protection and tranquility of the offer of its products, as the inconvenience caused by a large electrical surge goes beyond the financial losses. It is recommended that each device be separately protected with its most suitable Clamper.

4. Conclusion

Studies show that the use of SPD's can reduce the damage caused by overvoltages caused by lightning strikes or even those that may be caused by maneuvers or maintenance on the power grid.

It is believed that the use of SPD's will become more common, there should be an awareness of professionals, both those who design and install. Electronic equipment is a valuable asset that has been gained over the years and increasingly is a fundamental tool for human work. The loss of this equipment represents losses not only with maintenance or replacement, but, in most cases, the biggest losses are due to their unavailability.

By using SPD's, you get the assurance that the property is protected, but it is very important to use recognized, efficient and reliable products developed and manufactured by those who deeply understand the subject. The obtained results, showed the importance (SPD), is, therefore, the ideal solution to prevent against electric overloads and disturbances. It functions as a circuit breaker that can be installed either on the Switchboard or between the equipment and the power outlet (in this case individual).

Protects the internal supply circuits in the premises or equipment used from overloads caused by lightning surges with high voltage pulses, discharging it directly to earth via existing grounding conductors.

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