Lightning arresters essay

A lightning arrester Is a device used on electrical power systems and telecommunications systems to protect the Insulation and conductors of the system from the damaging effects of lightning. The typical lightning arrester has a high-voltage terminal and a ground terminal. When a lightning surge (or switching surge, which is very similar) travels along the power line to the arrester, the current from the surge is diverted through the arrestor, in most cases to earth.

In telegraphy and telephony, a lightning arrestor is placed where wires enter a Truckee, preventing damage to electronic instruments within and ensuring the safety of individuals near them. Smaller versions of lightning arresters, also called surge protectors, are devices that are connected between each electrical conductor in power and communications systems and the Earth. These prevent the flow of the normal power or signal currents to ground, but provide a path over which high-voltage lightning current flows, bypassing the connected equipment.

Their purpose Is to Limit the rise In voltage when a communications or power line Is struck y lightning or Is near to a lightning strike. If protection falls or Is absent, lightning that strikes the electrical system introduces thousands of kilovolts that may damage the transmission lines, and can also cause severe damage to transformers and other electrical or electronic devices. Lightning-produced extreme voltage spikes in incoming power lines can damage electrical home appliances.

Principle Of Lightning Arrester: The earthling screen and ground wires can well protect the electrical system against direct lightning strokes but they fail to provide protection against traveling waves, which may reach the terminal apparatus. The lightning arresters or surge diverts provide protection against such surges. A lightning arrester or a surge diverted Is a protective device, which conducts the high voltage surges on the power system to the ground.

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It consists of a spark gap in series with a non-linear resistor.

One end of the diverted is connected to the terminal of the equipment to be protected and the other end Is effectively grounded. The length of the gap Is so set that normal voltage Is not enough to cause an arc but a dangerously high voltage will break down the air Insulation and form an arc. The property of the non-linear resistance Is that Its resistance Increases as the voltage (or current) increases and vice-versa. This is clear from the volt/amp characteristic of the resistor Under normal operation, the lightning arrester is off the line I. E.

T conducts no current to earth or the gap is non-conducting (it) On the occurrence of over voltage, the air insulation across the gap breaks down and an arc is formed providing a low resistance path for the surge to the ground. In this way, the excess charge on the line due to the surge is harmlessly conducted through the arrester to the ground instead of being sent back over the line. (iii) It is worthwhile to mention the function of non-inner resistor in the operation of arrester. As the gap sparks over due to over voltage, the arc would be a short-circuit on the power system and may cause power-follow current in the arrester.

Since the characteristic of the resistor is to offer low resistance to high voltage (or current), it gives the effect of short-circuit. After the surge is over, the resistor offers high resistance to make the gap non-conducting.

Types Of Lightning Arrestors According To Class Station Class Station class arrestors are typically used in electrical power stations or substations ND other high voltage structures and areas. These arrestors protect against both lightning and over-voltages, when the electrical device has more current in the system than it is designed to handle.

These arrestors are designed to protect equipment above the 20 MBA range. 2.

Intermediate Class Like station class arrestors, intermediate class arrestors protect against surges from lightning and over-voltages, but are designed to be used in medium voltage equipment areas, such as electrical utility stations, substations, transformers or other substation equipment. These arrestors are designed for use on equipment in the range of 1 to 20 MBA. 3. Distribution Class Distribution class arrestors are most commonly found on transformers, both dry-type and liquid-filled.

These arrestors are found on equipment rated at 1000 kava or less. These arrestors are sometimes found on exposed lines that have direct connections to rotating machines. Secondary Class Secondary class lightning arrestors are designed to protect most homes and businesses from lightning strikes, and are required by most electrical codes, according to, Inc. , an electrical power protection company.

These arrestors cause high voltage overages to ground, though they do not short all the over voltage from a surge.

Secondary class arrestors offer the least amount of protection to electrical systems, and typically do not protect solid state technology, or anything that has a microprocessor Types Of Lightning Arresters: Types of Lightning Arresters for outdoor application There are several types of lightning arresters in general use. They differ only in path for the surges to the ground. 1 . Rod arrester 2.

Horn gap arrester 3. Multi gap arrester 4. Expulsion type lightning arrester 5. Valve type lightning arrester 5. Silicon Carbide Arrestors 7.

Metal Oxide Arrestors Rod Gap Arrester It is a very simple type of diverted and consists of two 1. 5 CM rods, which are bent at right angles with a gap in between as shown in Fig. One rod is connected to the line circuit and the other rod is connected to earth. The distance between gap and Insulator (I.

E. Distance P) must not be less than one third of the gap length so that the arc may not reach the insulator and damage it. Generally, the gap length is so adjusted that breakdown should occur at 80% of spark-voltage in order to avoid cascading of very steep wave fronts across the insulators.

The string of insulators for an overhead line on the bushing of transformer has frequently a rod gap across it. Fig 8 shows the rod gap across the bushing of a transformer.

Under normal operating conditions, the gap remains non-conducting. On the occurrence of a high voltage surge on the line, the gap sparks over and the surge current is conducted to earth. In this way excess charge on the line due to the surge is harmlessly conducted to earth. Limitations 1 . After the surge is over, the arc in the gap is maintained by the normal supply Olathe, leading to short-circuit on the system.

. The rods may melt or get damaged due to excessive heat produced by the arc. 3. The climatic conditions (e. G. Rain, humidity, temperature etc.

) affect the performance of rod gap arrester. 4. The polarity of the surge also affects the performance of this arrester. Due to the above limitations, the rod gap arrester is only used as a back-up protection in case of main arresters.

Horn Gap Arrester Horn gap arrester consists of a horn shaped metal rods A and B separated by a small air gap. The horns are so constructed that distance between them gradually increases towards the top.

The horns are mounted on porcelain insulators. One end of horn is connected to the line through a resistance and choke coil L while the other end is effectively grounded.

The resistance R helps in limiting the follow current to a small value. The choke coil is so designed that it offers small reactant at normal power frequency but a very high reactant at transient frequency. Thus the choke does not allow the transients to enter the apparatus to be protected. The gap between the horns is so adjusted that normal supply voltage is not enough to cause n arc across the gap.

Under normal conditions, the gap is non-conducting I. E.

Normal supply voltage is insufficient to initiate the arc between the gap. On the occurrence of an over voltage, spark-over takes place across the small gap G. The heated air around the arc and the magnetic effect of the arc cause the arc to travel Jp the gap. The arc moves progressively into positions 1, 2 and 3.

At some position of the arc (position 3), the distance may be too great for the voltage to maintain the arc; conducted through the arrester to the ground.

Multi Gap Arrester he multi gap arrester consists of a series of metallic (generally alloy of zinc) cylinders insulated from one another and separated by small intervals of air gaps. Rhea first cylinder (I. E. A) in the series is connected to the line and the others to the ground through a series resistance.

The series resistance limits the power arc. By the inclusion of series resistance, the degree of protection against traveling waves is reduced. In order to overcome this difficulty, some of the gaps (B to C in Fig) are shunted by resistance.

Under normal conditions, the point B is at earth potential and he normal supply voltage is unable to break down the series gaps. On the occurrence an over voltage, the breakdown of series gaps A to B occurs. The heavy current after breakdown will choose the straight – through path to earth via the shunted gaps B and C, instead of the alternative path through the shunt resistance.

Hence the surge is over, the arcs B to C go out and any power current following the surge is limited by the two resistances (shunt resistance and series resistance) which are now in series.

The current is too small to maintain the arcs in the gaps A to B and normal conditions are restored. Such arresters can be employed where system delegate does not exceed Kiev. Expulsion Type Arrester This type of arrester is also called ‘ protector tube’ and is commonly used on system operating at voltages up to Kiev.

Fig shows the essential parts of an expulsion type lightning arrester. It essentially consists of a rod gap AAA’ in series with a second gap enclosed within the fiber tube. The gap in the fiber tube is formed by two electrodes. Rhea upper electrode is connected to rod gap and the lower electrode to the earth.

One expulsion arrester is placed under each line conductor. On the occurrence of an over voltage on the line, the series gap AAA' spanned and an arc is stuck between the electrodes in the tube.

The heat of the arc vaporizes some of the fiber of tube walls resulting in the production of neutral gas. In an extremely short time, the gas builds Jp high pressure and is expelled through the lower electrode, which is hollow. As the gas leaves the tube violently it carries away unionized air around the arc. This denouncing effect is generally so strong that the arc goes out at a current zero and will not be re-established.

Advantages 1 .

They are not very expensive. . They are improved form of rod gap arresters as they block the flow of power frequency follow currents 3. They can be easily installed. 1 .

An expulsion type arrester can perform only limited number of operations as during each operation some of the fiber material is used up. 2. This type of arrester cannot be mounted on enclosed equipment due to discharge of gases during operation. 3. Due to the poor volt/amp characteristic of the arrester, it is not suitable for protection of expensive equipment Valve type arresters incorporate non linear resistors and are extensively used on yester, operating at high voltages.

Fig shows the various parts of a valve type arrester. It consists of two assemblies (I) series spark gaps. Lit) non-linear resistor discs in series. Rhea non-linear elements are connected in series with the spark gaps.

Both the assemblies are accommodated in tight porcelain container. Series Spark Gaps Rhea spark gap is a multiple assembly consisting of a number of identical spark gaps in series. Each gap consists of two electrodes with fixed gap spacing. The voltage distribution across the gap is line raised by means of additional resistance elements ladled grading resistors across the gap.

The spacing of the series gaps is such that it Nil withstand the normal circuit voltage. However an over voltage will cause the gap to break down causing the surge current to ground via the non-linear resistors.

Non- linear resistor discs in series Rhea non-linear resistor discs are made of inorganic compound such as thrive or metros. These discs are connected in series. The non-linear resistors have the property of offering a high resistance to current flow when normal system voltage is applied, but a low resistance to the flow of high surge currents.

In other words, the assistance of these non-linear elements decreases with the increase in current through them and vice-versa. Under normal conditions, the normal system voltage is insufficient to cause the break down of air gap assembly. On the occurrence of an over voltage, the breakdown of the series spark gap takes place and the surge current is conducted to earth via the non-linear resistors.

Since the magnitude of surge current is very large, the non-linear elements will offer a very low resistance to the passage of surge.

The result is that the surge will rapidly go to earth instead of being sent back over the line. When the surge is over, the non-linear resistors assume high resistance to stop the flow of current. Silicon Carbide Arrester Rhea Non linear lightning arrester basically consists of set of spark gaps in series with the silicon carbide non linear resistor elements. Lightning arresters are connected between the phase conductors and ground. During normal system operating voltage conditions, the spark gaps are non conducting and isolate the high tension (HTH) conductors from the ground.

However whenever an overlarge of magnitude dangerous to the insulation of the apparatus protected occurs (these over voltages r over surges may be caused due to lightning strikes on the conductors or due to Extra High Voltage (EVE) switching) the spark gap breaks down and allows the high delegate surge current to flow through the ground. Working Principle of Silicon Carbide (SIC) Lightning Arresters The volt-ampere characteristics of the non linear resistor in the lighting arrester can be approximately described by expression V = KIP. Where K and are dependent on the composition and manufacturing process of the Non linear Resistor (NIL).

The value of lies generally in the range of 0. 3 and 3.

5 for modern silicon carbide (SIC) lightning arresters. If the voltage across the Non Therefore, with multiple spark gaps arresters can withstand high Rate of Recovery Voltage (REV). The non-uniform voltage distribution between the gaps (which are in series in lightning arresters) presents a problem. To overcome this, capacitors and non-linear resistors are connected in parallel across each gap.

In case of lightning arresters employed for high voltage applications, capacitors and nonlinear resistors are connected across the stock of gaps and Nils.

With the steep voltage wave surge he voltage is mainly controlled by the capacitor and at the power frequency by the non-linear resistors. It is obvious that when the over voltages cause the break down of the series gaps, the current would be very high so as to make the voltage to subside very fast. The highest voltage that appear across the lightning arrester would be either the spark over voltage of the arrester or the voltage developed across the non-linear resistor during the flow of surge current.

The lowest spark over voltage of the arrester is called the hundred percent impulse spark over voltage of the arrester. He voltage developed across the non-linear resistor during the flow of surge current IS called residual voltage.

The lower the value of the voltage developed the better the protection of the lightning arrester. It should be recognized that over a period of operations that melted particles of copper might form which could lead to a reduction of the breakdown voltage due to the pinpoint effect.

Over a period of time, the arrester gap will break down at small over voltages or even at normal operating tollgates. Extreme care should be taken on arresters that have failed but the over erasure relief valve did not operate.

Disadvantages of Silicon Carbide (SIC) Arresters Some of the disadvantages of silicon carbide arresters compared to gapless arresters are given below:

Silicon Carbide (SIC) arresters have inferior V-I Characteristics compared to Zoon arresters (Metal oxide arresters). Decrease in energy absorption surge wave) capability compared to Zoon arresters.

Probability of sparking between the gaps. One major drawback is the gaps require elaborate design to ensure consistent spark- over level and positive clearing (resealing) after a surge passes.

Advantages of Silicon Carbide (SIC) Arrester Due to the presence of gaps the normal power frequency voltage during normal operation is negligibly less compared to gap less arresters. Hence no leakage current flow between the line and earth in SIC arresters Metal Oxide Arrestor Rhea MOVE arrester is the arrester usually installed today. The metal oxide arresters are without gaps, unlike the SIC arrester.

This " gap-less" design eliminates the high heat associated with the arcing discharges. The MOVE arrester has two-voltage rating: duty cycle and maximum continuous operating voltage, unlike the silicon carbide that just has the duty cycle rating.

A metal-oxide surge arrester utilizing zinc-oxide blocks provides the best performance, as surge voltage conduction starts and stops promptly at a precise voltage level, thereby improving system protection. Failure is reduced, as there is no air gap contamination possibility; but there is always a small ' alee of leakage current present at operating frequency.

It is important for the test personnel to be aware that when a metal oxide arrester is disconnected from an safety precaution, the tester should install a temporary ground to discharge any torte energy. Duty cycle rating: The silicon carbide and MOVE arrester have a duty cycle rating in XV, Inch is determined by duty cycle testing.

Duty cycle testing of an arrester is performed by subjecting an arrester to an AC arms voltage equal to its rating for 24 minutes. During which the arrester must be able to withstand lightning surges at 1- minute intervals.

Maximum continuous operating voltage rating: The MCCOY rating is usually 80 to 90% of the duty cycle rating. Installation Of Lightning Arrester Rhea arrester should be connected to ground to a low resistance for effective charges of the surge current. The arrester should be mounted close to the equipment to be protected & connected with shortest possible lead on both the line ground side to reduce the inductive effects of the leads while discharging large surge current. Maintenance Of Lightning Arrester Cleaning the outside of the arrester housing.

The line should be De-energize before handling the arrester. The earth connection should be checked periodically. To record the readings of the surge counter. The line lead is securely fastened to the line conductor and arrester.

The ground dead is securely fastened to the arrester terminal and ground. Components Simple spark gap device diverts lightning strike to ground (earth). A potential target for a lightning strike, such as a television antenna, is attached to the terminal labeled A in the photograph. Terminal E is attached to a long rod buried in the ground.

Ordinarily no current will flow between the antenna and the ground because there is extremely high resistance between B and C, and also between C and D. The voltage of lightning strike, however, is many times higher than that needed to move electrons through the two air gaps.

The result is that electrons go through the lightning arrester rather than traveling on to the television set and destroying it. A lightning arrester may be a spark gap or may have a block of semiconductors material such as silicon carbide or zinc oxide.

Some spark gaps are open to the air, but most modern varieties are filled with a precision gas mixture, and have a small amount of radioactive material to encourage the gas to unionize when the delegate across the gap reaches a specified level. Other designs of lightning arresters use a glow-discharge tube (essentially like a neon glow lamp) connected between the retorted conductor and ground, or voltage-activated solid-state switches Impressive devices, consisting of a porcelain tube several feet long and several inches in diameter, typically filled with disks of zinc oxide.

A safety port on the side of the device vents the occasional internal explosion without shattering the porcelain cylinder. Lightning arresters are rated by the peak current they can withstand, the amount of energy they can absorb, and the breaker voltage that they require to begin conduction. They are applied as part of a lightning protection system, in combination with air terminals and bonding.