HUBBELL® POWER SYSTEMS, INC.

OHIO BRASS®

Protecta*Lite® Systems

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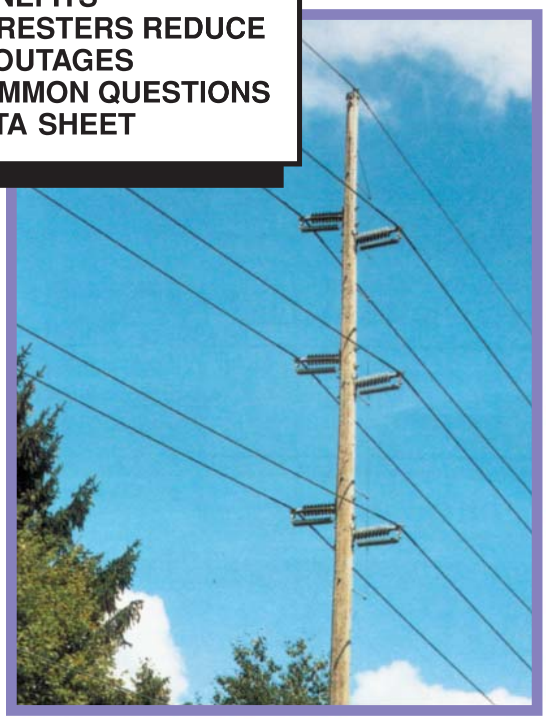

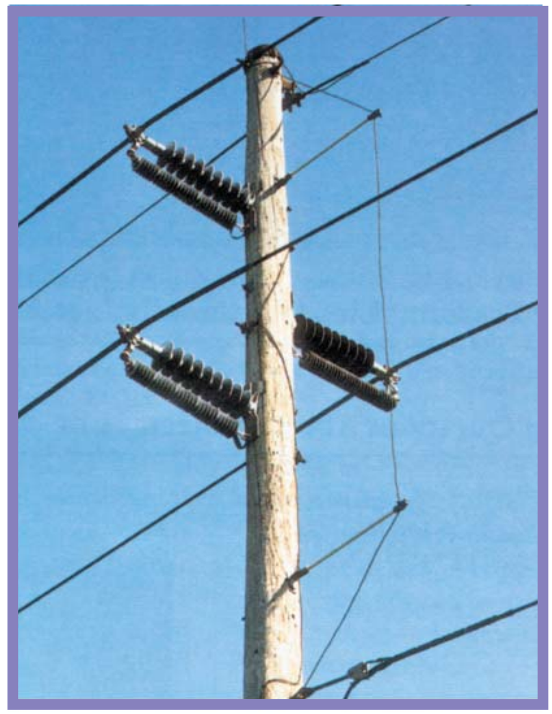

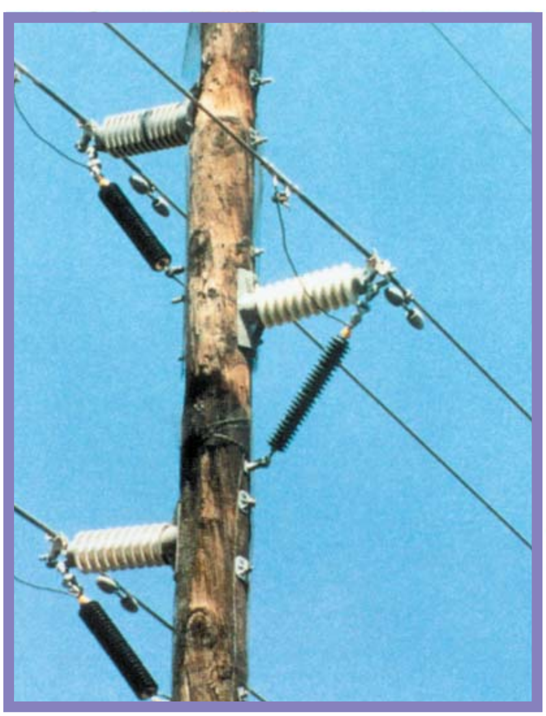

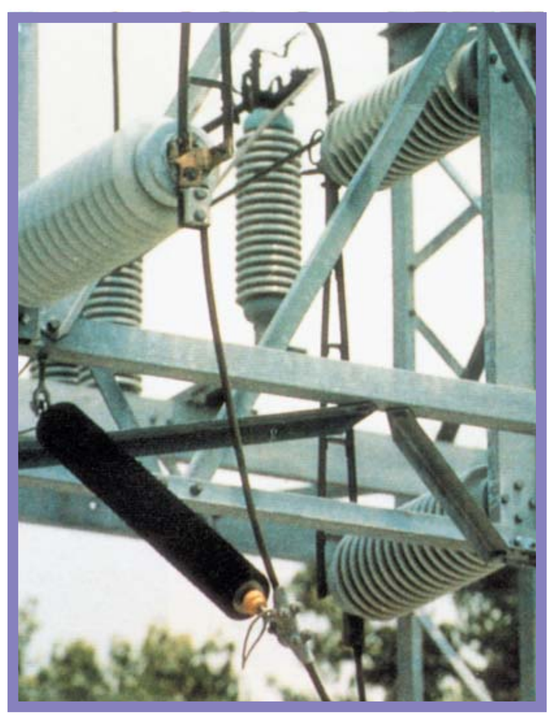

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Protecta*Lite® Systems

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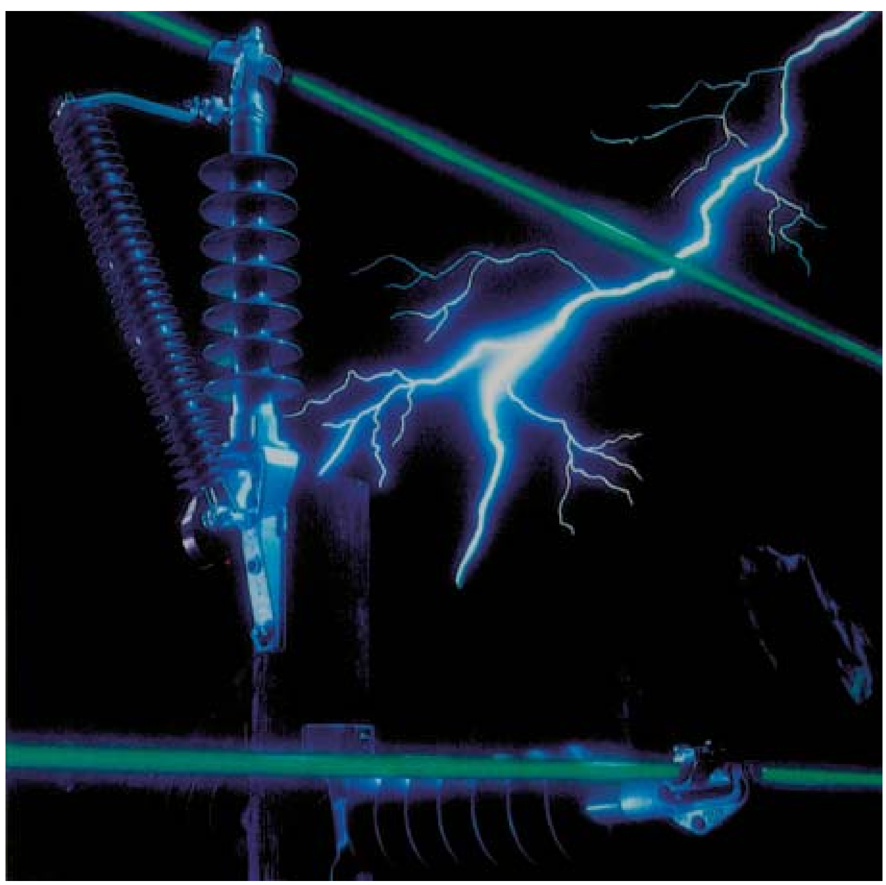


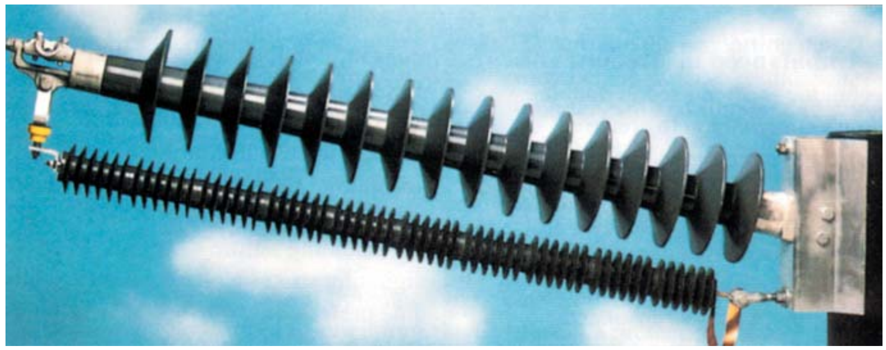
Protecta*Lite: A Complete Insulation And Protection System

In 1988, Ohio Brass introduced Protecta*Lite® Systems. Protecta*Lite is a blending of two proven technologies: Hi*Lite polymer insulators and polymer-housed DynaVar metal-oxide arresters. Protecta*Lite eliminates many of the disadvantages of conventional line protection using either porcelain-housed surge arresters or overhead shield wire.

The Protecta*Lite arrester reduces interruptions caused by lightning and can be applied as a supplement or as an alternative to overhead shield wire. This product is suitable for use on transmission and distribution systems ranging from 4,160 volts through 230,000 volts.

Protecta*Lite consists of polymer-housed surge arresters selectively placed in parallel with insulators on distribution or transmission lines. These arresters limit the voltage occurring across the insulator to a level below the flashover voltage. Protecta*Lite units properly applied on various T & D structures will achieve a line lightning interruption rate as good or better than that obtained with properly designed overhead shield wires. The Protecta*Lite assembly can be applied in areas with poor tower footing resistance and still obtain excellent lightning performance.

This product is suitable for new line construction or for existing structures. The Protecta*Lite assembly is available in a variety of designs and can be applied horizontally or vertically, on struts, suspension or on poletop insulators. This line protection system provides many design choices, including single phase or three phase applications and can be applied on virtually any type of structure configuration.



Protecta*Lite solves problems regarding lightning related complaints. Unshielded line performance can be improved to a level equal to or better than the reliability of a properly installed line with an OHSW. Protecta*Lite can be used to solve design problems where it is impractical or too costly to add height to a structure for the addition of an OHSW. (Photo: 138 kV Proteca*Lite)

Design Features

The Protecta*Lite design possesses high fault current withstand and resistance to contamination flashover.

In the unlikely event the arrester fails, it is automatically disconnected from the power system in a safe, controlled manner to prevent line lockout. There is clear visual evidence of arrester failure which allows rapid identification for replacement on a non-emergency basis.

Full system insulation is maintained under all normal and abnormal system operating conditions. The arrester has no internal atmosphere thereby preventing moisture ingress which is responsible for 98 percent of all conventional porcelain arrester failures.

Applications

The applications for Protecta*Lite on new and existing construction include:

Line compaction: The Protecta*Lite allows for maximum reduction in the width and height of transmission lines by elimination of overhead shield wires and prevention of phase to phase faults on compacted phase spacing.

Line uprating: Increased phase conductor clearances required for voltage uprating can be obtained without major structure modifications by elimination of shield wires and the replacement of porcelain insulators with lightweight polymer insulators. Protecta*Lite can provide primary system insulation, as well as improved reliability, low installed cost and an attractive installation in aesthetically sensitive areas.

Improve outage performance: The Protecta*Lite system will improve the outage performance of existing shielded and unshielded lines. This is accomplished by greatly reducing the frequency of line insulation flashover due to shielding failure and backflash. Protecta*Lite assemblies improve coupling factors and compensate for high ground (tower footing) resistance, which is often the cause of backflash on lines protected with overhead shield wires. Units are providing excellent service in many locations in the United States.

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Unbalanced insulation: This technique is often used in double circuit construction to create a sacrificial circuit in exposed locations. Lightning induced flashover of the circuit with less insulation usually protects the parallel circuit, which is normally the more critical of the two and the more heavily insulated. Protecta*Lite eliminates the need for a sacrificial circuit and can restore such circuits to full service.

General: There are many other local or general applications where Protecta*Lite will be of benefit. These include very high structures with long spans (river crossings, for example) and other terrain which make shield wires impractical or impossible.

Many circuits were built without shield wires because the expense was not justified or perhaps the circuits were not considered to be critical at the time of construction. In such cases it may be impractical to retrofit shield wires but Protecta*Lite can easily be installed to provide lightning protection.

Another consideration in retrofit is that overhead shield wires must generally be installed over the entire line to be effective. This requires a lengthy line outage. The same benefits can be obtained immediately with Protecta*Lite through selective, staged applications without a lengthy outage.

Definitions

It is important to be familiar with some terms necessary in the discussion of lightning performance and line protection.

Backflash — occurs when lightning strikes a grounded tower or overhead shield wire. The lightning discharge current, flowing through the tower impedance and tower footing resistance, produces a discharge voltage which appears across the line insulation. Backflash is most prevalent when tower footing resistance is high.

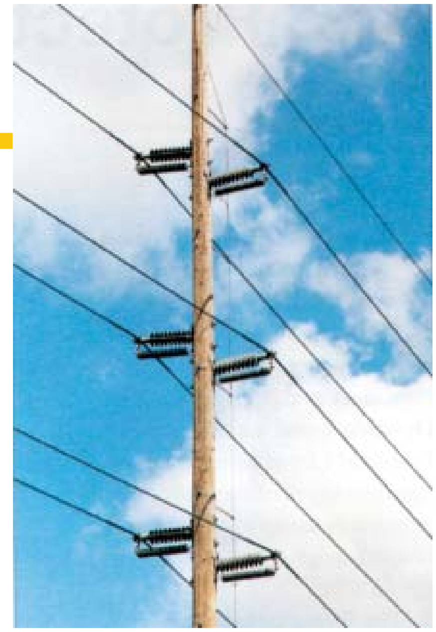
Shielding failure — occurs when lightning strikes a phase conductor of a line protected by overhead shield wires or by natural shielding.

Shield angle — is the included angle between a shield wire and phase conductor (or one protected phase conductor to an unprotected phase conductor).

Shadow angle — is the protective shadow of a transmission line cast on the surface of the earth below. Normally any lightning stroke within this shadow terminates on the transmission line. This angle is assumed to be $63\frac{1}{2}$ degrees on either side of the line and results in a shadow width that is four times the elevation of the highest conductor.

Isokeraunic level — is the number of annual thunderstorm days for a given region. The value is obtained from a contour isokeraunic map which is published periodically by the U.S. Weather Bureau. Isokeraunic levels range from five along the Pacific coast to 100 in Florida. It does not define the actual thunderstorm activity nor a precise number of annual thunderstorms. More accurate data on lightning density, and other lightning flash characteristics, are available from geographical lightning detection networks.[1]

Traveling wave — occurs when lightning strikes a transmission line span and a high current surge is injected onto the struck conductor. The impulse voltage and current waves divide and propagate in both directions



from the stroke terminal with magnitudes determined by the stroke current and line surge impedance at a velocity of 984 feet per microsecond.

Coupling factor — is the ratio of induced surge voltage on a parallel conductor to that on a struck conductor. This factor is determined from the geometric relationships between phase and ground (or protected phase) conductors. A value often used for estimation purposes is 0.25. The coupling factor, with corona considered, is calculated by the equation:

$$C = \frac{\log b/a}{\log 2h/r}$$

Where: C = coupling factor
b = distance from phase conductor to image of ground
a = distance from phase conductor to ground wire
h = height of ground wire
r = radius of ground wire

Tower footing resistance — includes total resistance of the tower and the tower to ground. This value is dependent upon soil resistivity and can be improved by driven ground rods or counterpoise.

Choices to be Made

Ohio Brass will help you study your line protection problems and will recommend one or more possible solutions for your consideration. Some decisions will need to be made, such as determining the desired level of lightning performance and the best methods of achieving that objective.

Lightning Performance Evaluation

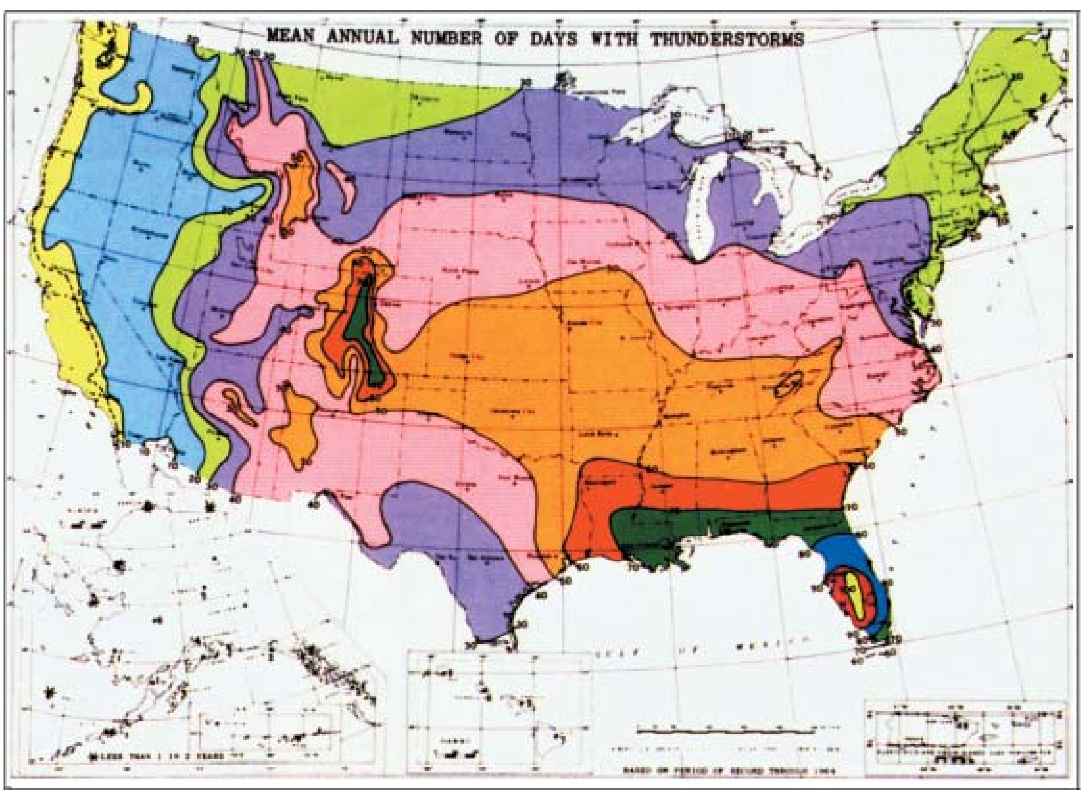
It is important to remember that lightning strokes to power lines are statistical events.

Procedures for estimating the lightning performance of lines and for selection and application of line protection are discussed in many papers, handbooks and other publications on the subject. These procedures all involve the following steps:

1. Determine the number of lightning strokes to the earth in the vicinity of the line (isokeraunic level or measured cloud to ground flash density).
2. Calculate the percentage of these strokes that are intercepted by the line (shadow angle).
3. Determine the proportionate numbers that strike at midspan, quarterspan and support structures.
4. Compute the number of strokes that are likely to cause insulator flashover.
5. If the line is currently in service, examine the historical operating performance.
6. Select a protection scheme that will most economically achieve the desired level of performance.

REFERENCE

1. **"Lightning Flash Characteristics: 1986"** EPRI EL-5667, Research Project 2431-1, Interim Report, February, 1988.



Arrester And Insulator Design Tests

Protecta*Lite® Insulation Designs

A Protecta*Lite assembly consists of the polymer-housed MOV surge arrester in parallel with any of the Ohio Brass insulators — Hi*Lite line posts, station posts or suspensions. With the appropriate hardware for mechanical and electrical connection, the Protecta*Lite is used for new construction, line compaction and other applications.

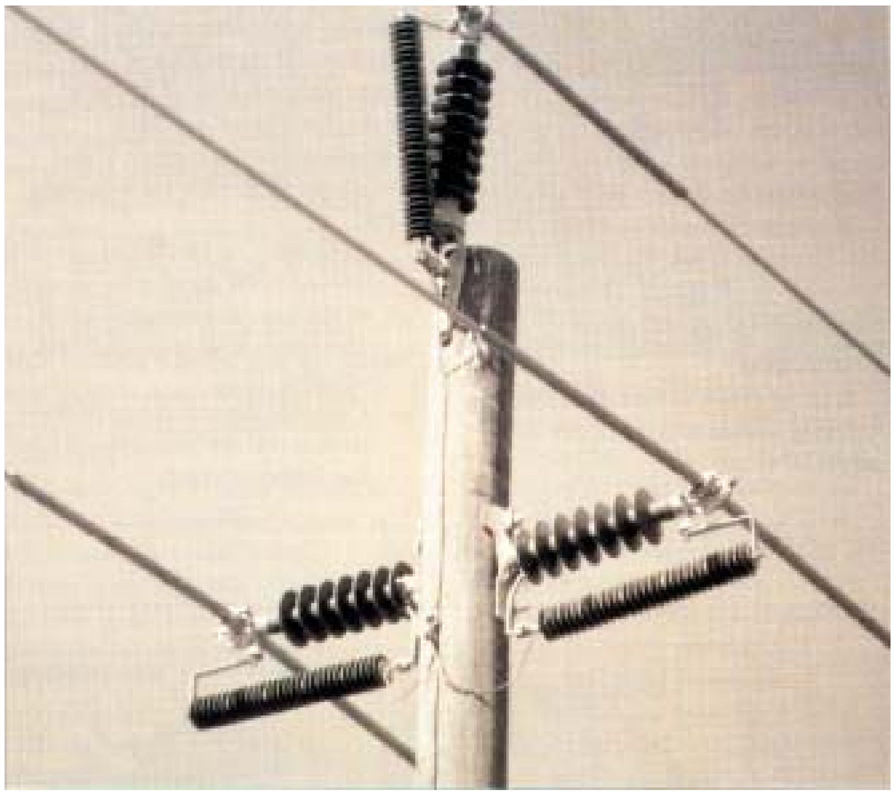
Protecta*Lite surge arresters are installed electrically in parallel with coordinated transmission and distribution insulators at the line support structures. In many retrofit applications the arresters can be used with the existing porcelain or polymer insulators.

ANSI C29.11 ("American National Standard For Tests To Composite Suspension Insulators For Overhead Transmission Lines") defines the tests to be performed and the acceptance criteria for tests to composite suspension insulators.

The Hi*Lite suspension insulators used in Protecta*Lite assemblies meet all requirements of ANSI C29.11 as well as the corresponding IEC 1109.

In the absence of ANSI standards for composite post insulators, Hi*Lite post insulators meet the applicable electrical, mechanical and dimensional requirements of ANSI C29.1 ("Test Methods for Electrical Power Insulators"), ANSI C29.7 (Line Posts) and ANSI C29.9 (Station Posts).

The structural member in both suspension and post insulators is a fiberglass rod of extremely high mechanical and dielectric strength. The weathersheds are injection-molded from proprietary ESP rubber alloyed to resist the oxidation, aging and degradation typically associated with an energized environment.



The hardware end fittings of all Hi*Lite insulators are directly swaged to the rod with a proprietary process. A resilient silicone dielectric compound interface between the fiberglass rod and protective weathersheds is an integral part of the Hi*Lite and Protecta*Lite designs for transmission voltages.

In addition to the design, conformance, and routine tests required or recognized by industry and utility standards, Hi*Lite insulators and their components have been subjected to a variety of special electrical, mechanical, thermal, contamination and weathering tests.

Test reports are available.

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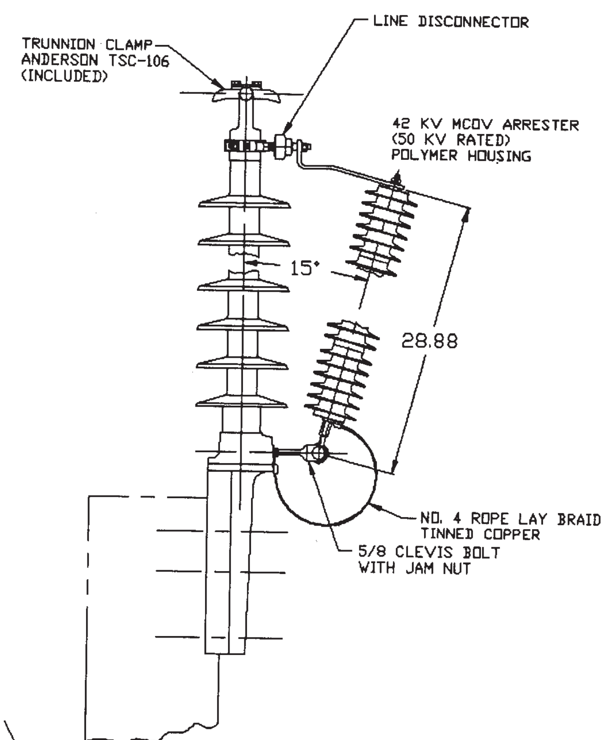
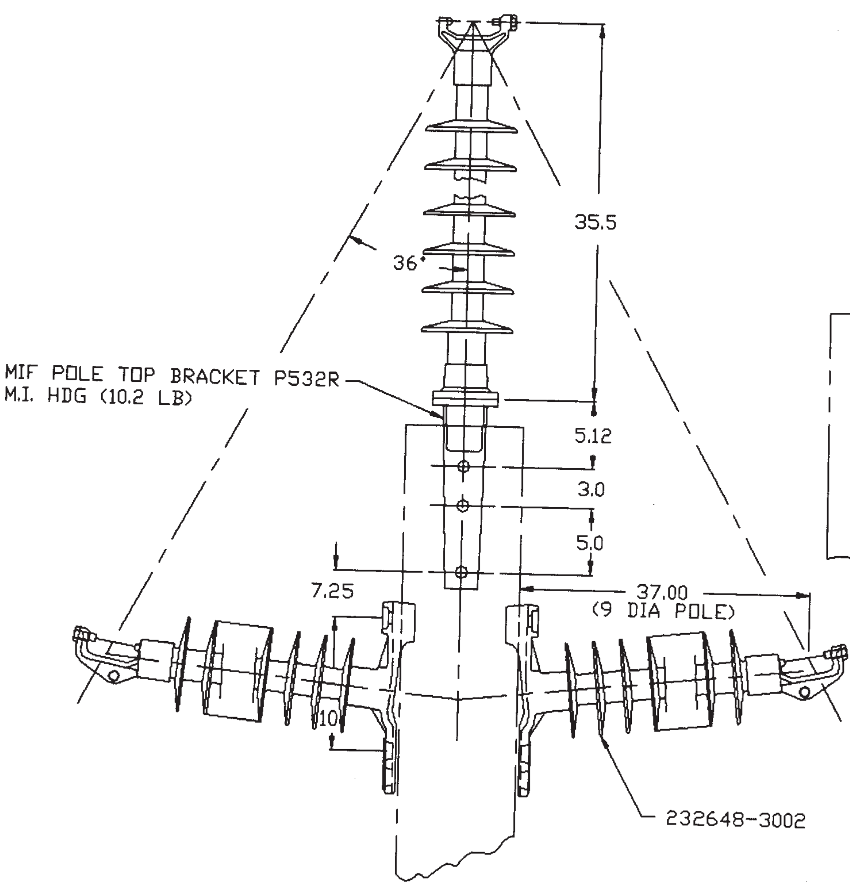




Evolution and Test of Protecta*Lite Arresters

Electric utilities have applied surge arresters on transmission systems for many decades. From the early 1930s to the late 50s, expulsion or protector tubes were used in new line construction instead of overhead shield wire. Experience with these early vintage arresters resulted in good line performance; however, excessive maintenance costs and limited life of these arresters eventually led to their obsolescence.

After the discontinuance of these early arrester designs, some utilities resorted to placing porcelain-housed intermediate or station class surge arresters on critical transmission structures. One of the primary design requirements in this application was the ability to vent excessive pressures generated during an arrester failure. The successful venting of these pressures eliminates or decreases the possibility of having an arrester explode in close proximity to an insulator or other equipment.

With the advent of the polymer arrester first introduced by Ohio Brass in 1986, pressure relief was achieved in an arrester at a fraction of the cost typically associated with an intermediate or station class arrester. The ability to obtain this pressure relief feature at a low cost, along with the excellent protective characteristics associated with MOV arresters, and a disconnector to prevent lockout, has allowed the polymer design to be installed economically on transmission systems.

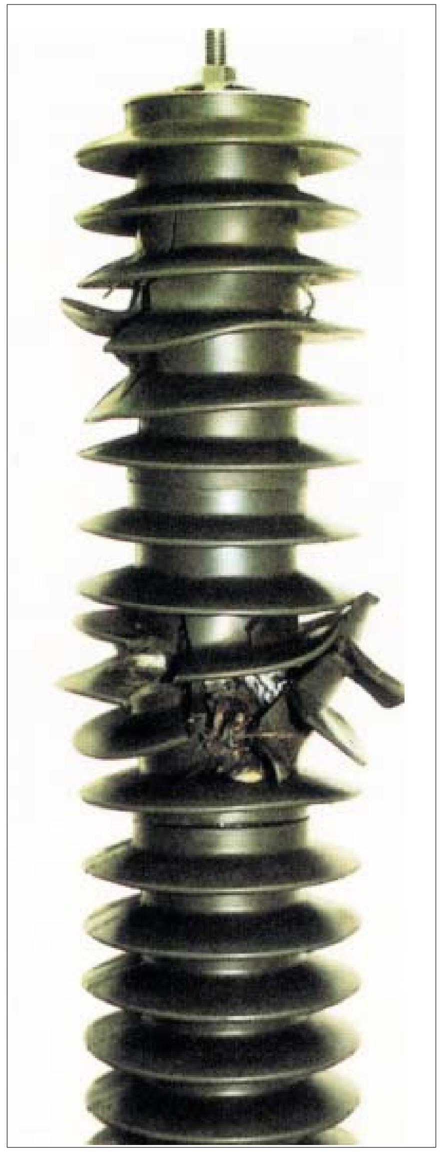
The ESP rubber-housed arrester with epoxy/fiberglass-wrapped MOV disc modules eliminates the major hazard of an arrester failure by not having a porcelain housing to explode if a power arc is established within the arrester. Moisture ingress is the major cause of conventional porcelain arrester failures. The ESP polymer-housed arrester has virtually no internal atmosphere and thus the problem of moisture ingress is eliminated. This technology has been expanded from distribution voltage levels to transmission voltages. The polymer arrester design is proven with its years of success.

Full Scale Fault Current Tests

A series of full voltage tests was conducted in accordance with Section 8.10 of ANSI/IEEE C62.11-1987 to determine the failure modes of the polymer arresters. The 8.4 kV MCOV Protecta*Lite specimens were assembled with fine fuse wire shunting the blocks before assembly within the module. As described by the standard, this technique simulates the result of arrester failure by internal dielectric breakdown.

Fault currents of 500 to 20,000 amperes RMS symmetrical for durations of 10 to 120 cycles were used in the Protecta*Lite arrester studies. Successful performance was demonstrated when the epoxy/fiberglass-wrapped modules either ruptured or burned through to relieve internal pressure. The polymer housings then split open to relieve pressure. At high fault currents, the housing may become detached from the MOV module. Since Protecta*Lite arresters are assembled by using modular construction, the test results are valid for all arrester voltage ratings.

The test sequence was recorded by ultra high-speed movies and still



A three-unit Protecta*Lite surge arrester with its polymer-housed epoxy/fiberglass wrapped metal-oxide disc modules ruptured to relieve internal pressure generated by a fault current arc of 10,000 amps for 10 cycles. Note the polymer housing has been split open, but the housing remains attached.

photographs of the before and after condition of the arresters. Additional tests were performed on 42 kV MOV arresters in accordance with the procedures outlined in Section 3.9 of ANSI/IEEE CC2.11.

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*Protecta*Lite Arrester*

Fault Current Withstand Ratings

Current Magnitude (Amps-Sym rms)	Test Duration (Cycles)
500	120
2,500	60
5,000	30
10,000	10
20,000	10

Note: If you would like a complete design test report on the Protecta*Lite arrester, please contact your Ohio Brass representative.

*Protecta*Lite Arrester*
Design Test Report Summary

Protecta*Lite arresters have been tested in accordance with ANSI Standard C62.11-1987 for metal-oxide surge arresters.

The table below summarizes the capabilities of these designs.

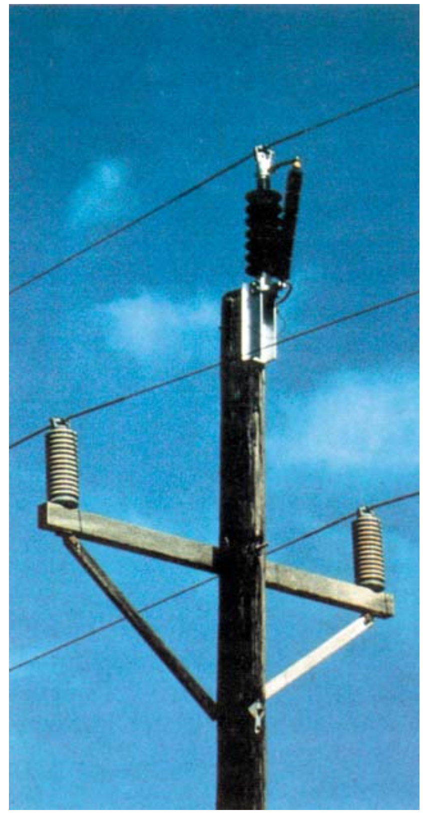
Test	Protecta*Lite
High Current Short Duration	2 -100 kA Discharges
Low Current Long Duration	20 - 250A x 2000 µsec Discharges
Duty Cycle	20 - 10 kA plus 2 - 40 kA Discharges

The above is merely a summary of a portion of the design tests performed on Protecta*Lite arresters. Contact your Ohio Brass representative for complete test reports on these two arresters.

Protecta*Lite® Benefits

Protecta*Lite Benefits:

- Eliminates or substantially reduces breaker operations resulting in less maintenance and improved service reliability.
- Equivalent performance to an overhead shield wire can be obtained by using an arrester on the top phase only. Like shield wire, success is dependent on a good ground.
- Performance superior to an OHSW can be obtained by using arresters on all three phases. Unlike shield wire, success is not limited by the requirement for a good ground.
- When Protecta*Lite is installed on all three phases, shielding failures and backflash problems are virtually eliminated.
- Easy to install on either new or existing structures.
- Installation can be accomplished on an "as needed" basis. It may not be necessary to include these as a "budget item".
- May be installed in "trouble zones" only.
- Can be installed on lines with an OHSW to eliminate backflash problems caused by poor grounding. In many cases this is less expensive than improving grounds which may average $1,500 to $2,000 per structure.
- Electrical losses are minimal.
- Polymer material has a life expectancy in excess of 50 years.
- Hi*Lite insulators, commercially available since 1976, have proven polymer durability.
- Metal-oxide varistor technology has existed since 1976. The life expectancy of MOV blocks far exceeds the expected life of any transmission line.
- The concept of placing arresters on transmission lines is not new. Expulsion tubes have successfully protected transmission lines for decades. The design shortcomings associated with expulsion tubes have been overcome.
- The Protecta*Lite arrester has an unlimited discharge life.
- The polymer arrester has been available since 1986 with an electrical failure rate less than .002 percent in environments with the most severe lightning duty.
- The Protecta*Lite arrester can pass 100,000 amp discharges and remain in service.
- The Protecta*Lite arrester has a "no lockout" feature.
- Upgrading transmission lines is facilitated with Protecta*Lite by the ability to use existing structures, right-of-way, and in some instances the same insulators.
- Protecta*Lite arresters offer a clean appearance and are more aesthetically appealing than a taller structure with an OHSW.
- Protecta*Lite arrester is available in combination with an insulator for new construction or without an insulator for retrofit applications.



Note: When installed on top phase only, "shielding failures" are still possible. The chance of this occurring are the same as what could be expected from an OHSW. Also, "backflash" is still possible in this configuration if grounding is not adequate. Neither of these shortcomings is a consideration if Protecta*Lite is installed on all three phases.

Hanging Protecta*Lite Arresters Reduces Outages On 115 kV Line

Excessive outages on a 115 kV line crossing a mountainous terrain in the northeast corner of Georgia were apparently caused not by shielding failure but by backflash. A helicopter survey using gyrostabilized binoculars showed that the lightning-induced damage was occurring all along the line and was not limited to the mountaintops.

Nick Bledsoe, PE, division transmission engineer at Georgia Power Co. explains that, when lightning strikes the overhead groundwire or a grounded tower, the discharge current flowing through the tower impedance and the footing resistance produces a voltage drop that appears across the line insulator. If this voltage exceeds the insulator impulse withstand voltage, a flashover from the tower to the conductor results. The 60-Hz follow-through may cause a phase-to-ground fault and service interruption.

Backflash occurs most often when footing resistance is high and unfortunately, low footing resistance is difficult to achieve in Georgia's mountainous areas. In 1986, the line suffered the unacceptable number of 16 interruptions.

The solution selected by Georgia Power was to place metal-oxide arresters in parallel with selected line insulators. Total cost and tower designs made it impossible to locate arresters on every phase of every structure, so the devices were spread out, with the proviso that there was at least one arrester on every third structure.

Wherever possible, structures that allowed arresters on all three phases were protected, as well as structures that exhibited obvious lightning damage.

The arresters chosen were Protecta*Lite metal-oxide arresters, supplied by Ohio Brass. These arresters are of modular, lightweight construction and are hung below the insulators, with the energized end attached to a suspension clamp installed upside down over the conductor armor rod. The ground end of the arresters is connected to the tower leg with No. 2 AWG copper leads. This method of installation has the additional benefit that failed units are easier to spot.

The arresters are rated at 100 kV with a maximum continuous operating voltage of 88 kV and 100,000-amp surge current capability. With a 20,000-amp surge current, the discharge voltage generated is 398 kV, well below the impulse flashover of a seven-insulator string.

John Reason, Senior Editor
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Electrical World Magazine
April, 1989

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Protecta*Lite arresters, which weigh only 35 lbs., are installed below line insulators.

Common Questions About Protecta*Lite® Systems

Do utilities have any lines which experience poor performance?

Nearly every utility has some critical line(s) or customer(s) which require uninterrupted or improved service. According to an IEEE panel discussion, lightning causes 40 percent of customer outages nationally and is responsible for 50 percent of all customer complaints.

What are the applications for Protecta* Lite?

■ New Lines ■ Rebuild
■ Upgrade projects
■ Unshielded Lines ■ Backflash

What is the mean lightning stroke current?

The mean lightning stroke current magnitude is 35 KA for negative polarity according to an EPRI study. Negative polarity strokes account for 81 percent of all lightning strokes to earth. The remaining strokes (19 percent) are positive polarity with a mean current magnitude of 55 KA. Positive polarity strokes are most prevalent in the winter months and travel a greater distance through air than the negative strokes. This is because positive charges are generally located at the top of clouds and a greater potential exists at the time of the lightning stroke. Cold (sub-freezing) temperatures tend to result in a greater tendency to form positive strokes.

What happens when a transmission or distribution line is struck by lightning?

If the line is unprotected, there is an 80 to 99 percent chance that the insulators will flashover. When this occurs, a power-arc will be established around the insulator and it is most probable that an arc will persist until a breaker or recloser operates.

If the line is protected with a well grounded overhead shield wire, the lightning surge will successfully be discharged to ground without flashing-over the insulators.

If the line is protected with a poorly grounded shield wire, backflash may occur on the phases with the lowest coupling factors.

What methods are available to improve lightning performance?

■ Installing a well grounded overhead shield wire with an adequate shield angle. This option is comparatively expensive to install and at some voltages, operating losses are high. Also, some utilities comment that shield wire needs replacement every 20 to 25 years as a result of corrosion. Shield wires are known to fail mechanically which can result in sustained outages on transmission lines.

■ Improving grounds on transmission lines protected with an overhead shield wire. This can be expensive ($1,500 to $2,000 per structure) and may need to be done repeatedly over the life of the line.

■ Adding extra insulation. This is generally not cost effective. On an unprotected line, increasing BIL levels from 100 kV to 700 kV (700 percent increase) will only decrease the probability of flashover from 98 percent to 86 percent.

■ Adding expulsion or protector tubes. While these have been discontinued by manufacturers, these old style arresters have provided good performance for many utilities from 1930 through present day.

■ Adding Protecta*Lite arresters. This is an economical, proven method to increase line performance on all installations. These state-of-the-art arresters are capable of successfully discharging 100 KA lightning strokes and remain operative. They have a life expectancy well in excess of the typical transmission line and their design has overcome the shortcomings of the old expulsion tube type arresters. Operating costs are minimal and installation is simple and quick. Protecta*Lite installation and materials cost 50 to 75 percent less than the cost of installing overhead shield wire on an existing 69 kV line.

What is backflash?

This event is the insulator flashing-over on phase conductors which have a low coupling factor. Backflash is generally the cause of interruptions on shielded lines experiencing a large number of tripouts. Backflash is most prevalent in areas where poor grounding exists and thus, lightning induced voltages on structures are highest. The phases with the lowest coupling factors have the highest voltage stress across the insulators during a lightning discharge. Backflash can occur on lines protected with an overhead shield wire or on lines protected with Protecta*Lite arresters installed on the **top phase only**. The success of both of these protective schemes is dependent on a good ground. **If Protecta*Lite arresters are installed on all three phases, backflash problems due to poor grounding can be eliminated.**

What is the probability of backflash?

The probability of backflash can be calculated from system parameters, line geometry, and statistical lightning data. Simplifications in the backflash analysis can be made by calculating the individual phase coupling factors, measuring the structure ground, evaluating the probabilities for lightning strokes of various current magnitudes, and then applying Ohm's law. The voltage stress across the various insulators can then be evaluated. In general, the better the ground, the lower the probability of backflash occurring. Protecta*Lite can be used to effectively improve the coupling factors, thus reducing the probability of backflash.

*What is the performance of Protecta*Lite vs. OHSW?*

Protecta*Lite arresters, properly installed and grounded on a top phase only protection scheme, will perform as well or better than a line protected with a properly installed overhead shield wire. Protecta*Lite arresters installed on all three phases will perform better than a line protected with an overhead shield wire since backflash potential and shielding failure are eliminated.

What is the effect of ground resistance?

Ground resistance is a significant contributing factor to the voltage potential induced on a structure during a lightning strokes. This is simply an application of Ohm's law. For a given stroke current, the higher the resistive path to ground, the greater the impressed voltage.

*What is the energy loss of Protecta*Lite vs OHSW?*

Protecta*Lite arresters have a very low energy loss of 2.5 watts per arrester for 138 kV applications. Shield wire has an energy loss which may cost a utility thousands of dollars per year per mile for an equivalent application. Shield wire losses are dependent on line current magnitude,

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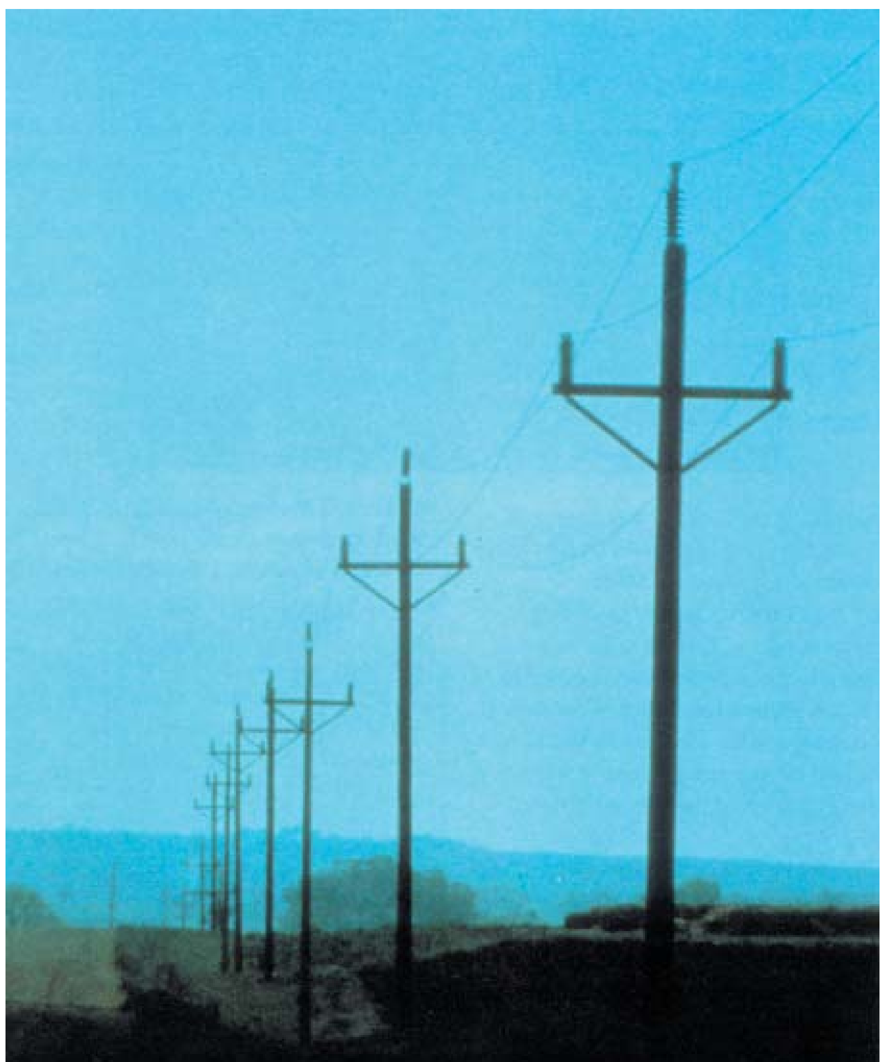
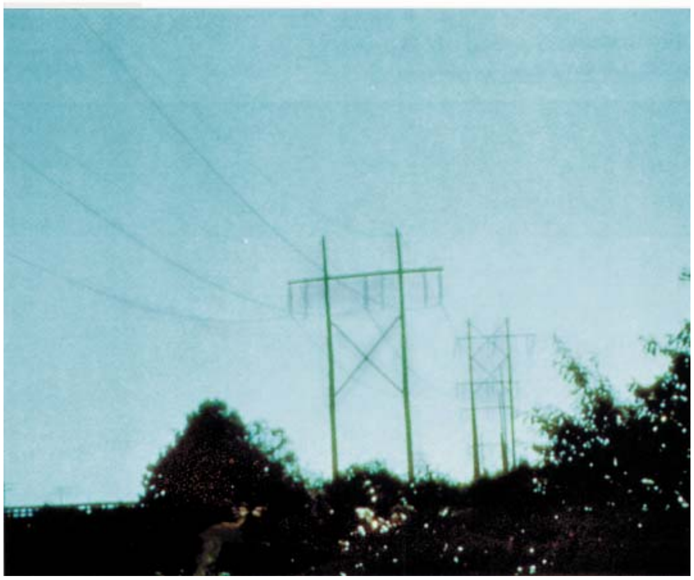




line configuration, voltage, energy production cost, grounding, and other factors. As ground resistance is lowered (improving the shielding performance of OHSW), the losses also rise since power loss is equal to I^2R. As ground resistance is decreased, a corresponding increase in shield wire current occurs and its contribution to energy loss is to the second power.

*Should we install Protecta*Lite on one phase or all three phases?*

This answer depends on individual applications and design parameters. In many cases it is more economical to install arresters on all three phases as the arresters can be spaced further apart and footing resistance is less critical. The increased spacing leads to reduced labor costs. In other cases, it is more economical to space arresters every other or every third structure, on the top phase only, if good grounds exist at all structures. If backflash is a problem on shielded lines, it is generally most economical and effective to place Protecta*Lite arresters on the lower phases only.

*What is the probability of shielding failure? Do the same rules apply for Protecta*Lite as those which apply to OHSW?*

Shielding failure occurs when lightning strikes a phase conductor instead of the overhead shield wire or a top phase protected with a Protecta*Lite arrester. The probability of shielding failure can be estimated using methods described in the EPRI, "Transmission Line Reference Book." The same calculations used to calculate the performance of a line with OHSW can be used to estimate top phase only arrester protection. It should be noted that when arresters are applied to all three phases, shielding failures are eliminated since all phases can successfully discharge lightning to ground without flashing over the insulators.

*Does structure impedance contribute to the success of Protecta*Lite?*

Yes, wood crossarms, structures, and any other impedance can add to the insulating characteristics and impulse strength of the insulators applied on the structure. These same resistances can also detract from the overall success of a top phase only arrester application or OHSW application if these members add impedance to the successful discharge of a lightning stroke to ground.

What is the effect of eliminating the static wire as a neutral?

If the neutral is used for communication, there are some drawbacks. Most utilities use other methods for communicating.

According to several experts, the elimination of the neutral will not affect most relaying schemes. Those which do rely on the neutral for relaying can easily be modified to accommodate Protecta*Lite. Modern relaying schemes typically are capable of sensing ground faults in many different ways.

*What is the effect of the Protecta*Lite® System on substation equipment and insulation?*

Protecta*Lite will lessen the duty seen by substation equipment through a reduction in breaker operations, switching surges, and transients the substation must withstand. Many older substations have aged equipment which can benefit from reduced operations caused by events occurring on the transmission line.

*What is the effect of Protecta*Lite on current relaying schemes?*

Very few lightning strokes have a duration in excess of 1,000 microseconds. A "fast" relaying scheme will react in two cycles, or 33,333 microseconds. Thus we see that the actual event of discharging a long surge through an arrester is an insignificant amount of time when considering relaying.

How many arresters should we place per structure?

The function of Protecta*Lite depends on the degree of performance you require and the application. Factors which affect these values are listed in the Data Sheet enclosed. A general rule of thumb, however, is to use 12 to 15 arresters per mile.

*What is the experience of utilities using Protecta*Lite?*

Every utility which has installed Protecta*Lite arresters has had a favorable experience. Many of these same utilities are purchasing hundred or thousands of additional units to install on other transmission and distribution lines. Utility engineers are excited about how successful this product is and how it is solving many of their quality power operating problems cost effectively.

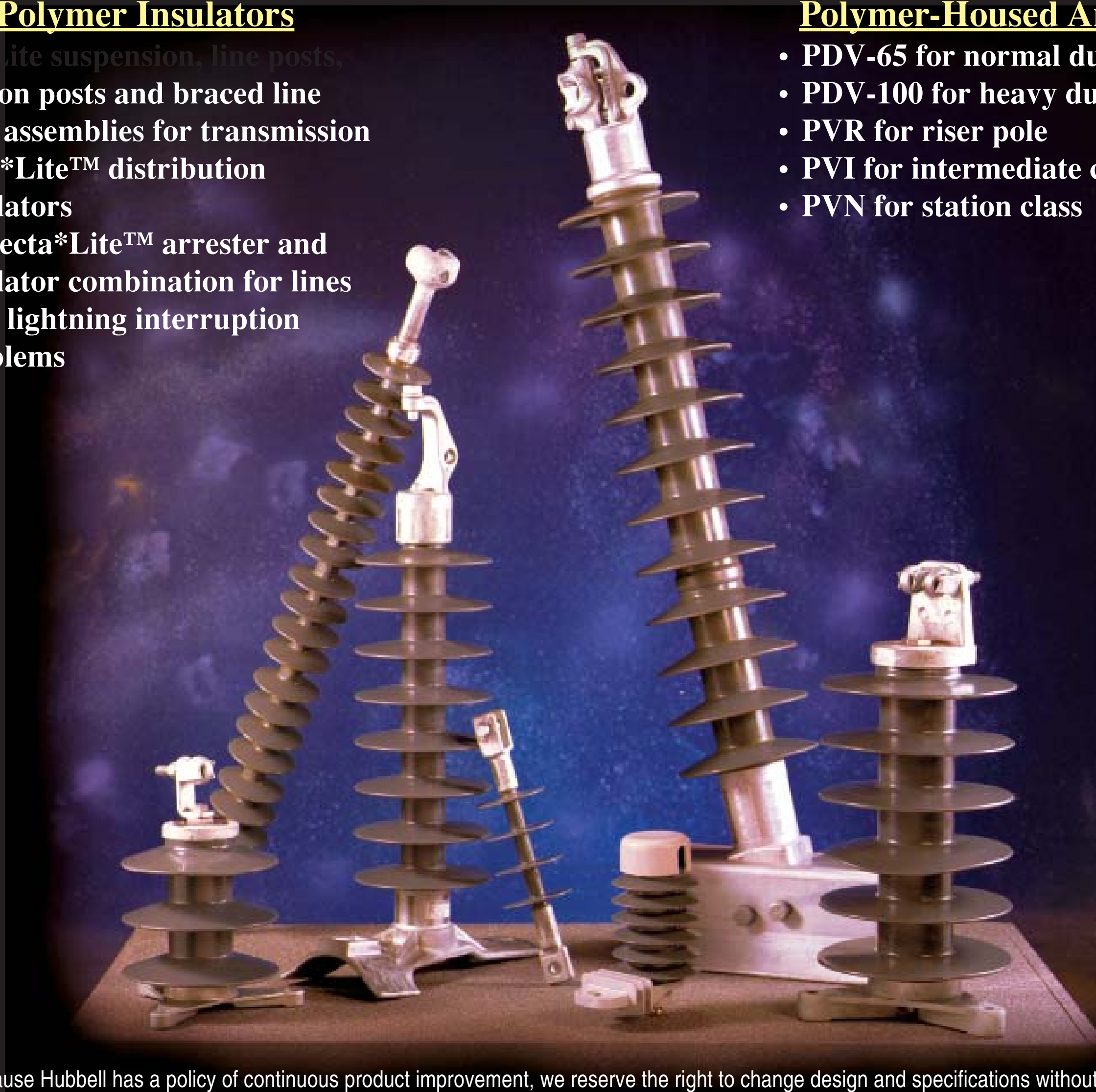
*What is the probability of performance of Protecta*Lite?*

If properly applied, Protecta*Lite can be used to eliminate practically all lightning induced interruptions. Predicting probabilities is somewhat involved, yet given the parameters set forth in the Data Sheet, we can prepare a recommendation and estimate the probable performance.

OHIO BRASS

Quality Products for over 100 years

Ohio Brass manufactures a complete line of transmission and distribution arresters and insulators. Over six million PDV arresters protect distribution lines and over 6,000 miles of transmission line have been built with Hi*Lite® insulators worldwide.



Polymer Insulators

- Lite suspension, line posts, station posts and braced line post assemblies for transmission
- Veri*Lite™ distribution insulators
- Protecta*Lite™ arrester and insulator combination for lines with lightning interruption problems

Polymer-Housed Arresters

- PDV-65 for normal duty
- PDV-100 for heavy duty
- PVR for riser pole
- PVI for intermediate class
- PVN for station class

NOTE: Because Hubbell has a policy of continuous product improvement, we reserve the right to change design and specifications without notice.

HUBBELL® POWER SYSTEMS, INC.

573-682-5521 Fax 573-682-8714 http://www.hubbellpowersystems.com

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