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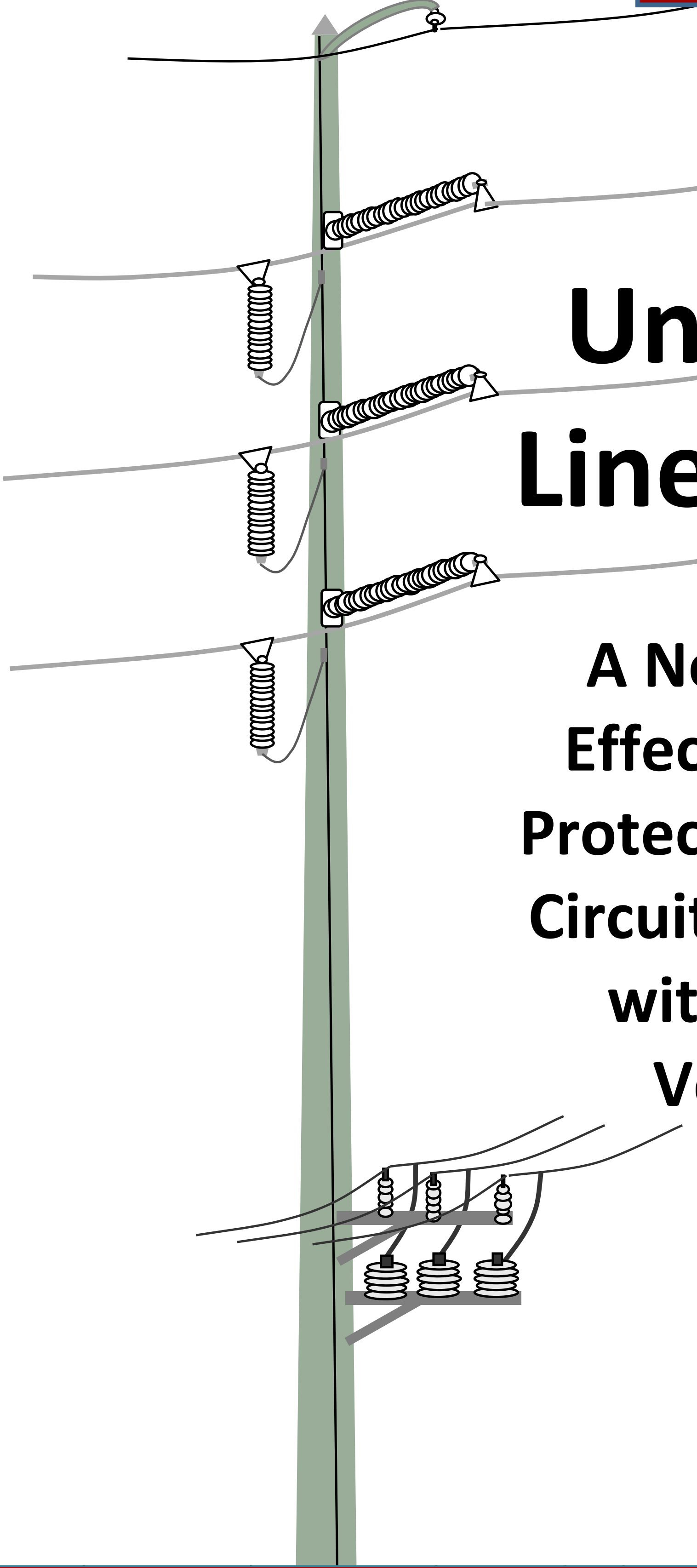

The Underbuilt Line Arrester

A Novel and Cost Effective Means of Protecting Underbuilt Circuits from Contact with the Higher Voltage Line

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Introduction

The underbuilt line arrester is a simple solution to a problem that has plagued overbuilt distribution circuits for decades – namely, protection from sustained overvoltage events. With the exception of the term underbuilt line, these are the opening words of a recently published IEEE paper by Dan Ward an IEEE Fellow employed at Dominion Virginia Power. I agree with Dan and his new concept, that this is a simple and effective means of mitigating a serious safety and equipment problem that has up until now been unsolved. This ArresterFacts summarizes and adds to the IEEE paper titled "OverVoltage Protectors – A Novel Concept for Dealing with Overbuilt Distribution Circuits"

Definitions

Underbuilt Line Arrester
Any arrester that clamps the power frequency voltage rapidly to ground during a sustained overvoltage event and holds it there until reset (or removed).

Overbuilt Construction
This is a type of power system construction where two separate circuits are supported by the same pole. The upper circuit can be 50 to 500% higher in voltage than the circuit built below.

Underbuilt Circuit
The lower voltage circuit (generally a distribuiotn circuit) constructed beneath a distribution or transmission circuit.

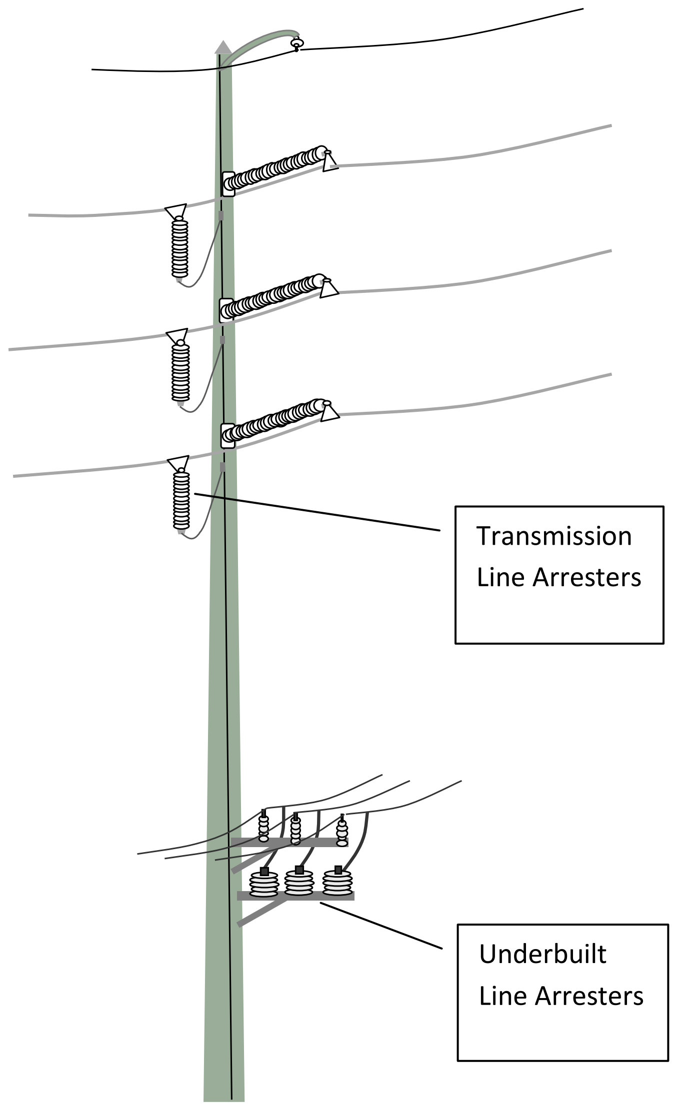


Figure 1 Overbuilt Circuit Configuration with Underbuilt Line Arrester and Transmission Line Arresters

The Problem

When two overhead circuits of different voltages exist on the same poles, the possibility exists that contact between the two circuits will occur. When this happens, damage and failures occur to utility equipment on the lower voltage circuit and to customers' end use equipment served from the lower voltage circuit. When contact is made, the voltage on the lower voltage rises until its arresters overload and set off their disconnectors if so equipped. The standard distribution arrester may explode if it is a porcelain type or if it is a more contemporary polymer housed arrester it may just become a short until its disconnector operates. In either case, it most likely has protected the circuit during the initial contact, however if the higher voltage circuit has a reclose operation, the voltage on the lower voltage circuit immediately increases to levels that do damage on the lower voltage circuit since the distribution arresters are effectively out of the circuit.

Historical Solutions

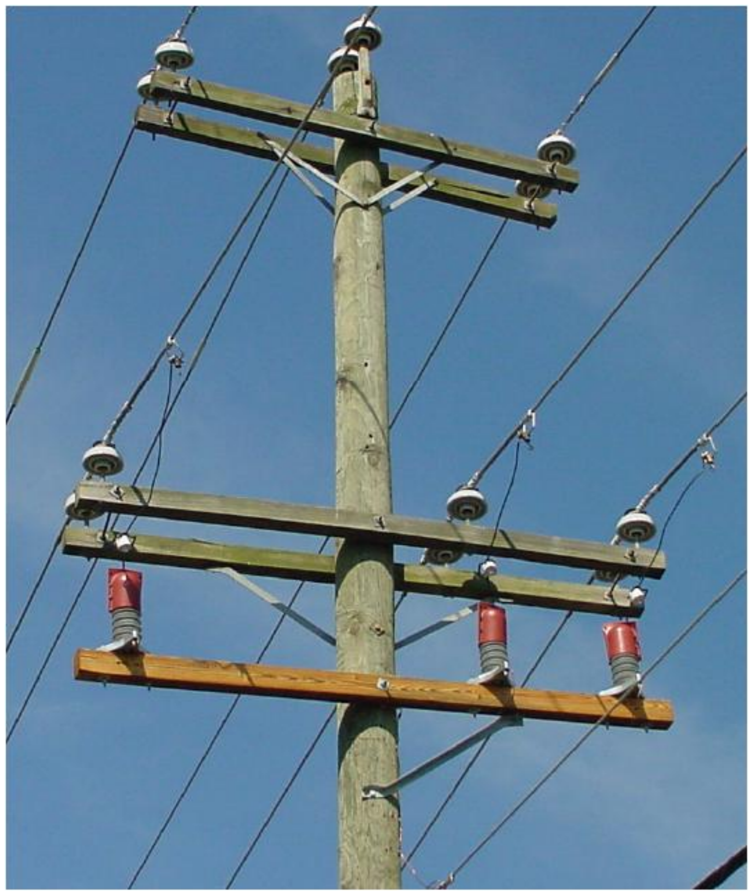
The most common solution is no solution at all. The risk is accepted and if an event occurs, the utility pays for the damages.

A less common but effective solution is to relocate the circuits and in some cases move the distribution circuit underground. Moving the circuit underground for one or two spans is quite often seen where a transmission line crosses a distribution line, however when the run concurrently on the same poles for miles, this solution is very costly.

If the difference in the two system voltages is not significant, sometimes the lower voltage circuit is converted to the higher voltage.

In some countries, this author has seen where a ground grid is installed between the two systems and in the case of a line drop of the high voltage circuit, it is intercepted by a grounded grid.

In all these historical solutions, the effort is considerable and the cost even more so. That is why the most common solution is to allow the insurance policy pay. As the cost of these events increases and the constant growing demand for more safety in power delivery the no solution option is rapidly becoming unacceptable.



Courtesy of Dominion Virginia Power

Figure 2 Close-up of Underbuilt Line Arresters

A New Concept

What Dan Ward has put forth as a simple solution seems so obvious, that one has to wonder why it was not consider much before this. Since arresters are capable of clamping power frequency overvoltages, he believed if the arrester was specified correctly it could be used as the protector in these high voltage contact events, so that is exactly what he did.

For this special arrester the following is required.

1. Must be rated so that it will clamp a sustained power frequency overvoltage to levels below the withstand of electronic equipment attached to the lower voltage system.
2. Must remain on the circuit after the initial event and through any re-energizations of the high voltage line.
3. Since it cannot be equipped with a disconnector, it must be of very high reliability and not likely fail in the presence of lightning.
4. When overloaded, it must result in a near short circuit.

When applying this type of arrester on the lower voltage circuit of an overbuild system the lower voltage circuit is effectively immune to a line drop from above.

The arrester is most likely sacrificed during the event, but this is an insignificant cost as compared to the cost of damaged equipment for miles along the lower voltage circuit.

The arrester that meets the above criteria for this application is simply a high energy station class polymer housed arrester.

The reason a standard polymer housed station class arrester was chosen is because it meets all the listed specifications.

1. Their MCOV can be specified to be equal or lower than the distribution arresters on the lower voltage circuit and can clamp power frequency at levels that do not result in damage to equipment on the lower voltage circuit.
2. This arrester design is very robust and will not disintegrate or explode during a high fault current event.
3. High energy rated station class arresters are equipped with very large diameter disks that are very resistant to lightning thus making them more reliable than a distribution arrester. This is more necessary when the arresters are not effectively shielded as they are in this example.
4. When overloaded, this type of arrester becomes nearly a short circuit and is not equipped with a ground lead disconnector.

Speed of Overload

Not by design, but more by luck, the overload (or TOV capability) speed of most arresters is quite fast compared to the withstand time of equipment connected to service voltage. This is shown in figure 3. Because arresters are designed to clamp lightning and switching surges, they are generally not capable of riding through very

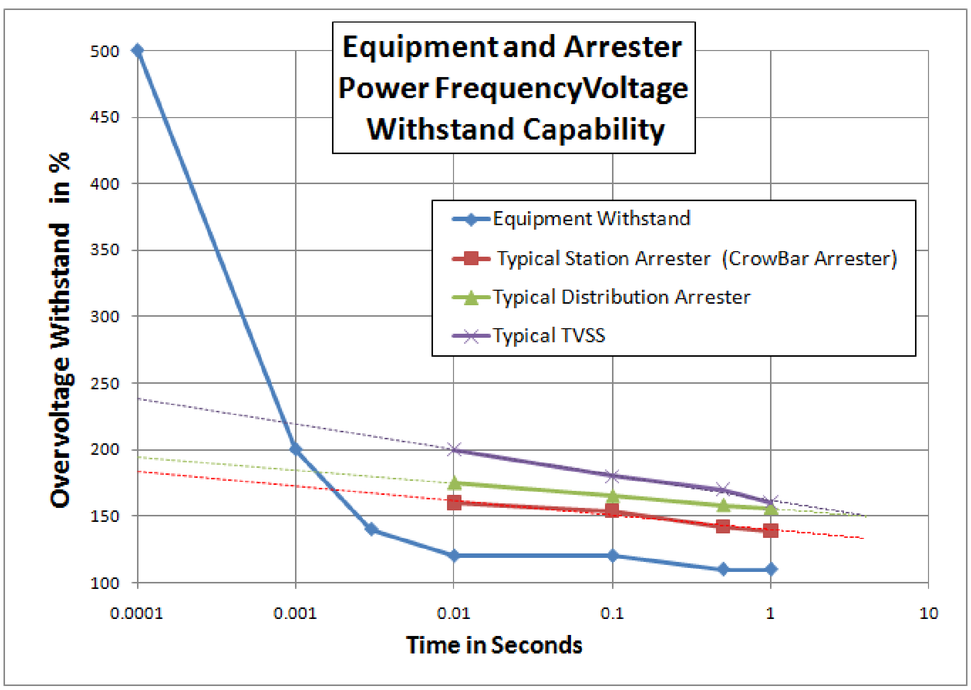


Figure 3 Overload Speed of Arresters and Withstand of Equipment

high power frequency overloads. Their rapid conversion to a short circuit is an advantage in this application.

Installation and Selection Considerations

Location – The arresters only need to be installed on the lower voltage system. Since this issue is a power frequency (50-60 Hz) issue, the location of the underbuilt line arrester is not critical. Almost anywhere on the circuit will work. Of course closer to the source of the fault will be better, but not critical. One arrester must be installed on each phase. One arrester at each end of the overbuilt line is recommended only for redundancy sake and it is further recommended that one set per mile be installed.

Grounding: It is recommended that the arresters have a good ground (10-30 ohms). This will help insure quick overload and the lowest clamping voltage possible.

Wildlife Protective Devices: Since these arresters are not equipped with ground lead disconnectors, it is imperative that they do not experience a failure due to animals. If they are failed due to an animal, the resulting outage will be much longer than desired. If at all possible, use as large a wildlife guard as possible to insure that wildlife cannot compromise the circuit at this critical arrester.

Fault Current Withstand: When selecting the arrester, make sure the fault current withstand of the arrester is higher than the available fault current of the higher voltage line as well as the lower voltage line.

Faulted Circuit Indicators: Installing these devices on the line or grounded side of the arrester may be helpful in locating a faulted unit. They can be seen in figure 2 just above the arresters.

Future Work

This application is new and untested with time. It appears to be an excellent and simple solution to this age old issue. Anyone with experience and comments on this issue are encouraged to email me at jwoodworth@arresterworks.com and share your experiences.

Other ArresterFacts Available

- Arrester Lead Length
- Field Testing Arresters
- Infrared Thermometer
- Guide for Selecting an Arrester Field Test Method
- VI Characteristics
- The Externally Gapped Arrester (EGLA)
- The Disconnector
- Understanding Mechanical Tests of Arresters
- What is a Lightning Arrester?
- The Switching Surge and Arresters
- The Lightning Surge and Arresters
- Understanding the Arrester Energy Handling Issue
- Understanding Discharge Voltage
- What is a Riser Pole Arrester?
- Selecting Arrester MCOV and Uc

ArresterFacts Usage

Thank you for using www.ArresterWorks.com as a source of information on high voltage surge arresters.

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