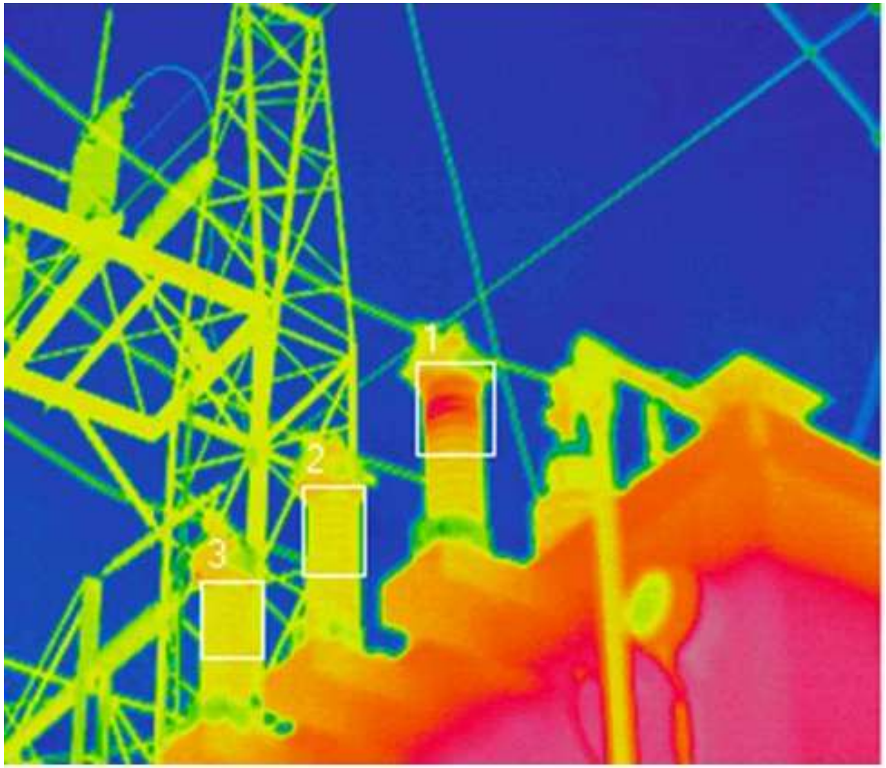
ArresterFacts-002
Field Testing Arresters

ArresterWorks.com

ArresterFacts are information modules pertaining to the arrester world.

This Field Testing of Arresters module will clarify the many questions about assessing the quality of an installed high voltage arrester as applied to power systems.



Anyone interested in commenting on this module is welcome to do so. Send comments to Jonathan Woodworth at jwoodworth@arresterworks.com

Field testing arresters comes in many forms.

Vref Tests

Partial Discharge Tests

Thermal Tests

Leakage Current

Dielectric Tests

Watts Loss Tests

This ArresterFacts will show you the Facts on each!

Typical Substation Arrester Mounting
Is this a well functioning arrester or is the small hole in the side a problem? Line personnel are faced with this question on a routine basis.

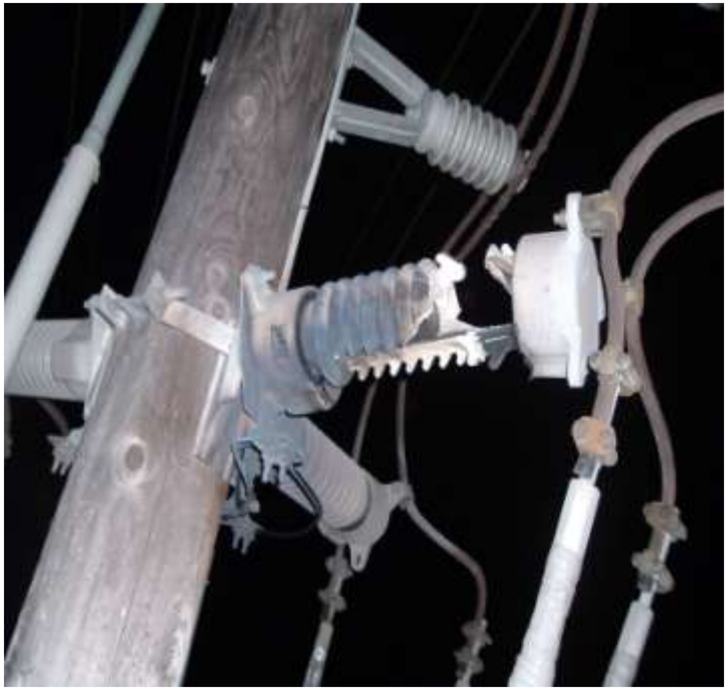
Why Do Arresters Require Testing at all?

It is common knowledge that arresters age just like all other components on power systems.

- **Since most arresters are directly connected to the system, they are exposed to voltage stress continuously.**
- **Since most arresters are exposed to the elements during their entire life, their seals are stressed continuously.**
- **Since most arresters are exposed to surges of many amplitudes some are over stressed.**

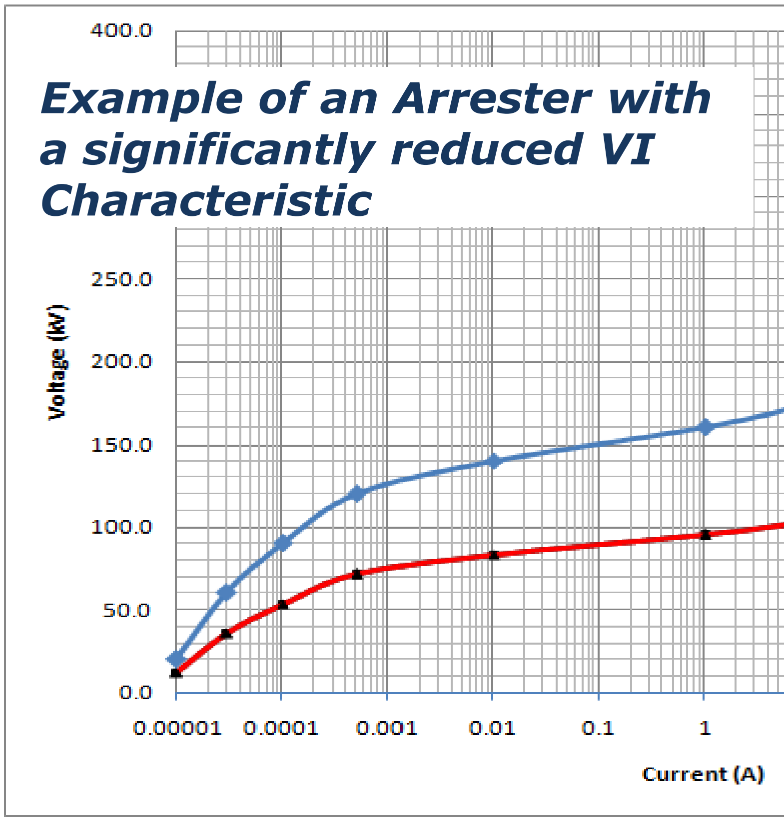
Since most arresters are stressed in the most onerous ways, they do experience an end-of-life event at some time.

The purpose of field testing is then to predict the arrester's end-of-life and remove it from the system avoiding an outage due to an unexpected failure.



In short, arresters are tested to avoid this…

Example of an Arrester with a significantly reduced VI Characteristic



Common characteristics of arresters nearing end-of-life

1. **The unit can exhibit higher temperatures through-out or in one spot.**
2. **Partial discharge may be present at steady state voltages.**
3. **The VI Characteristic might have changed.**
4. **Leakage currents may have increased significantly.**
5. **Watts loss may have increased.**
6. **Physical damage**

Note: None of the above may be present and an arrester may be near end-of-life so standard high voltage precautions should be used at all times

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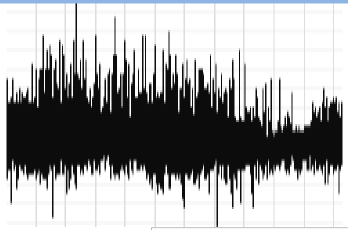
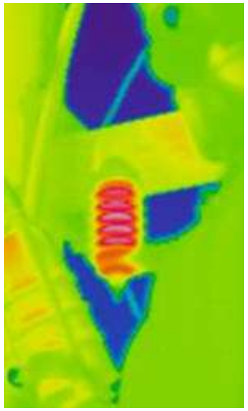
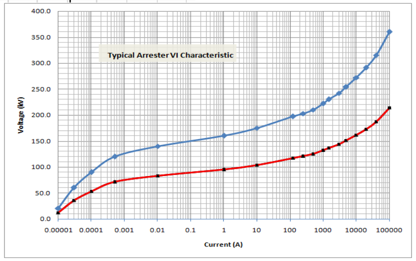
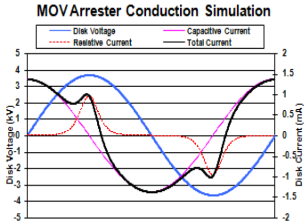
Common Arrester Field Testing Methods



- Infrared Thermography
- Partial Discharge Detection
- VI Characteristics Change
- Leakage Current
- Watts Loss

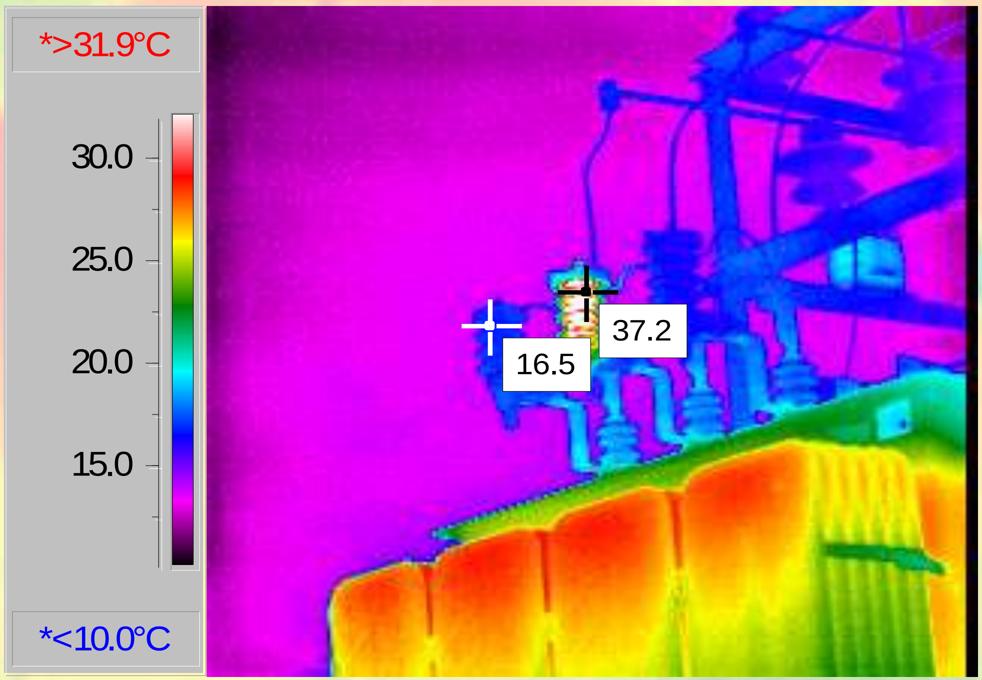






Infrared Thermography

What is the temperature difference that should cause concern?



Infrared Thermography

The fastest growing method of assessing the condition of arresters is with the use of infrared thermography. The reason for its popularity is its clear differentiation between a good arrester and one nearing the end of life.

The reasons for its lack of pervasive use however is because of two issues.

1. The equipment to perform the analysis is not common toolbox gear.
2. The process can be time consuming.

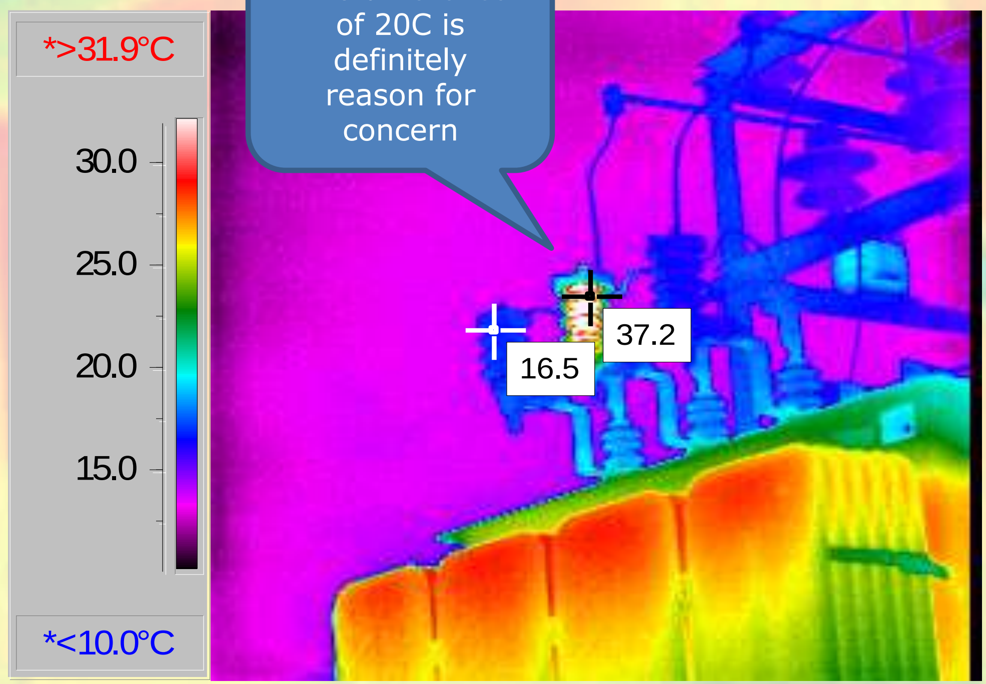
Infrared Thermography

The most significant issue with Infrared Thermography is that if the arrester is not energized, it will not exhibit overheating and cannot be assessed.

Infrared Thermography

What is the temperature difference that should cause concern?

This difference of 20C is definitely reason for concern



Infrared Thermography

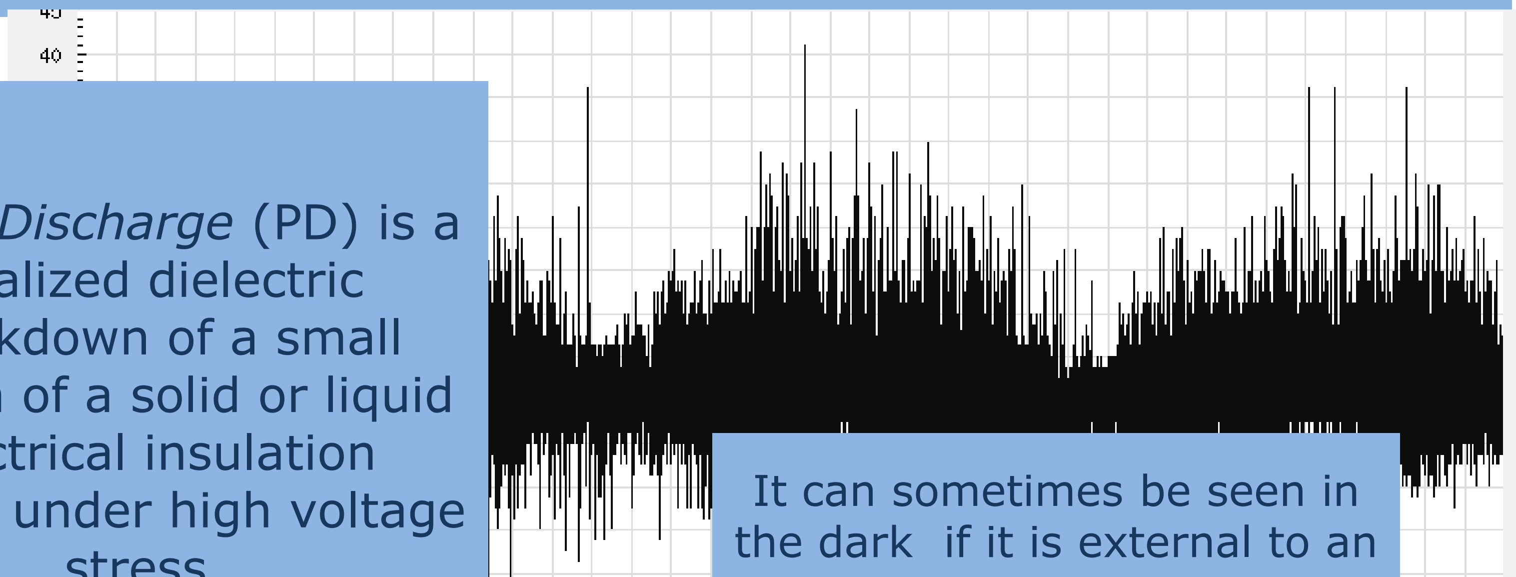
As a Rule:

1. Scan 2 or more of the same arrester types and vintage
2. Compare the temps of all scanned arresters
3. If hot spots on one are more than 10C different than the others, have it removed in the near future

Cost Effective and Fast Infrared Thermography

A cost effective IR Thermometer that measures temperature from as close as a few inches to a 100 feet are readily available. Not only faster, but can be safer than working near a hot arrester.

Partial Discharge Detection



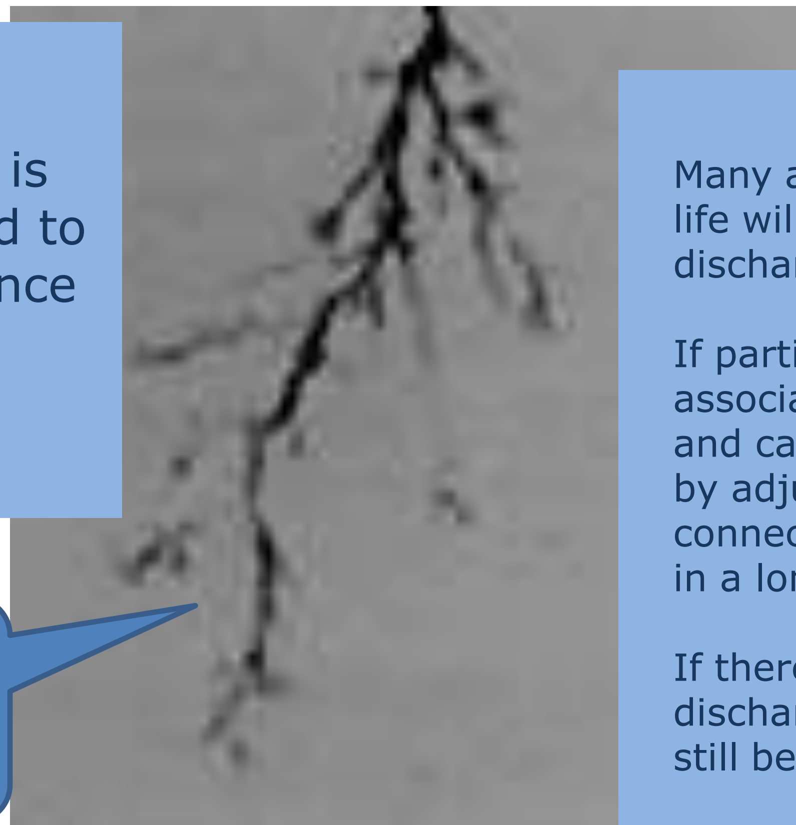
Partial Discharge (PD) is a localized dielectric breakdown of a small portion of a solid or liquid electrical insulation system under high voltage stress.

It can sometimes be seen in the dark if it is external to an arrester.

It can sometimes be heard if external to the arrester

Partial Discharge Detection

Partial Discharge is sometimes referred to as Radio Interference Voltage (RIV)



Typical treeing along the internal components of a failing arrester. This PD would most likely be detectable

Many arresters near end of life will exhibit partial discharge **but not always**.

If partial discharge is associated with an arrester, and cannot not be eliminated by adjusting the external connections, then it is likely in a long term failure mode.

If there is no sign of partial discharge however it could still be near end of life.

Partial Discharge Detection

PD Detection Equipment is widely available, however few models are portable and could not be considered common toolbox gear

Partial Discharge Detection

AM Radios can very effectively be used as a partial discharge detector. The AM bands on a radio are very sensitive to damaging levels of Partial Discharge.

This is why it is sometimes referred to as Radio Interference Voltage.

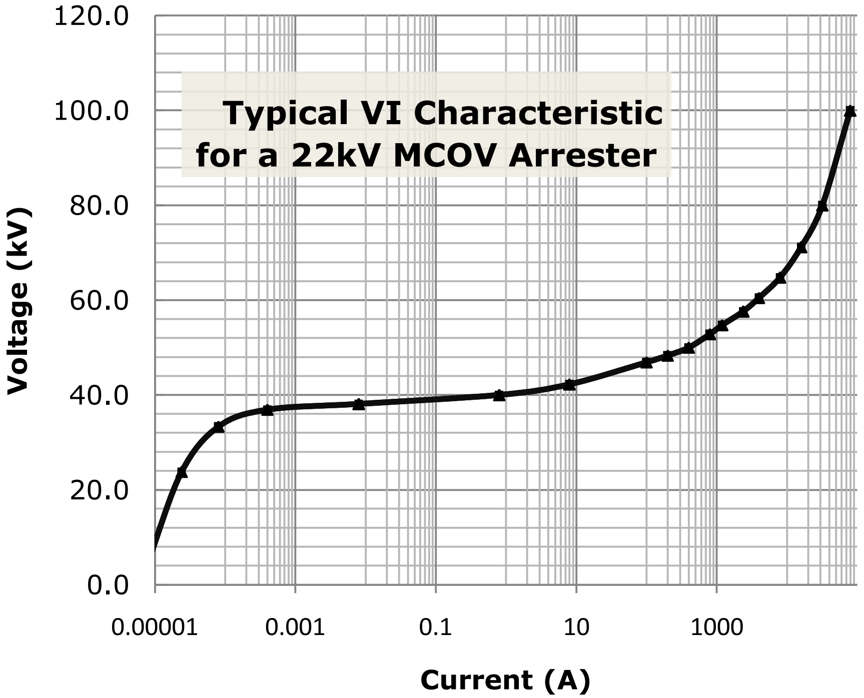
No! Satellite Radio won't work…..

Partial Discharge Detection

Portable Acoustic Detectors are an option

Acoustic Detectors can be used to locate partial discharge, however the level must be quit high to detect.

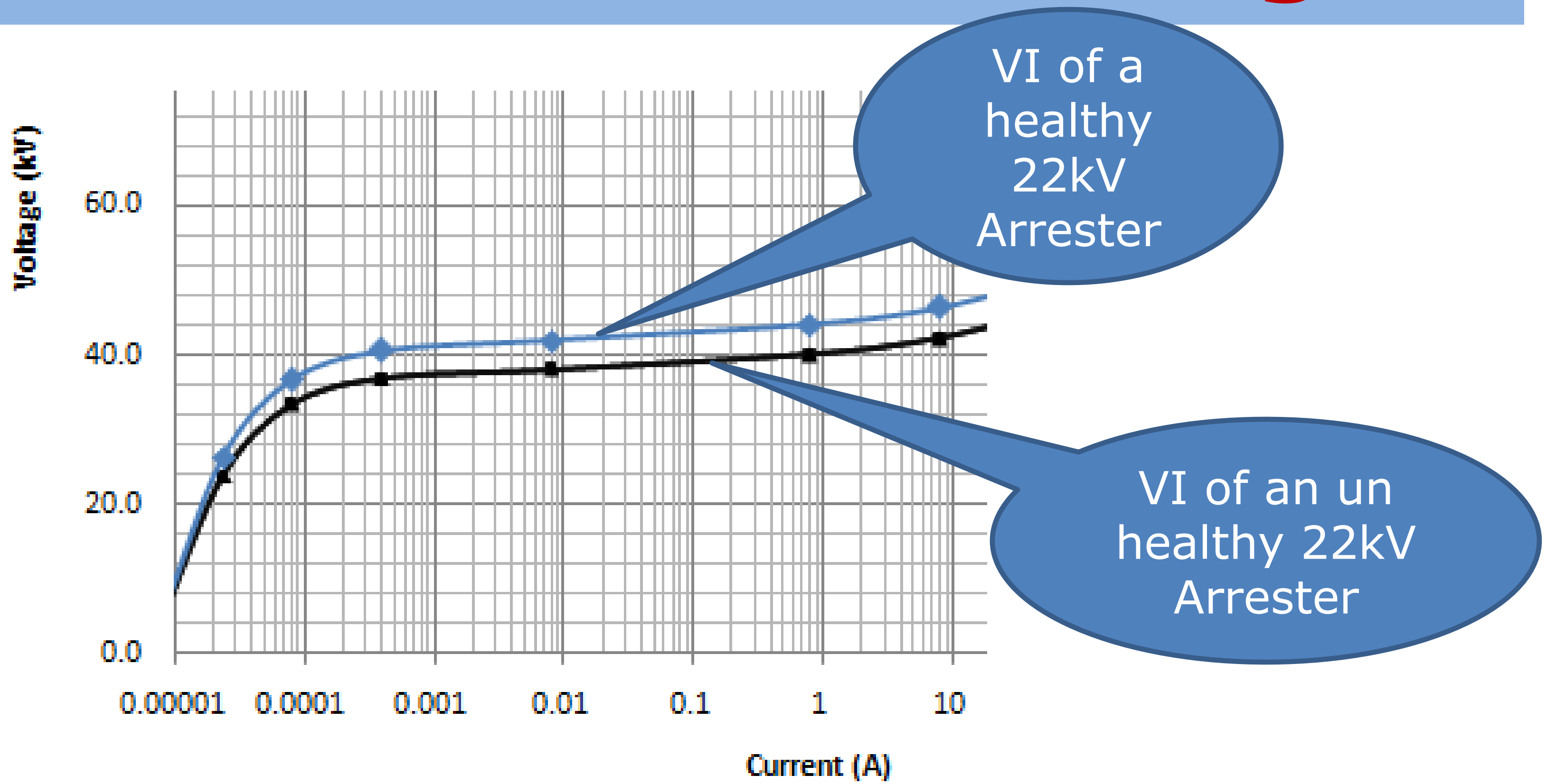
VI Characteristic Change



The arrester VI characteristic is one of the most fundamental descriptors of the health of an arrester.

Leakage Current, Watts Loss and Vref tests all measure different aspects of this characteristic.

VI Characteristic Change

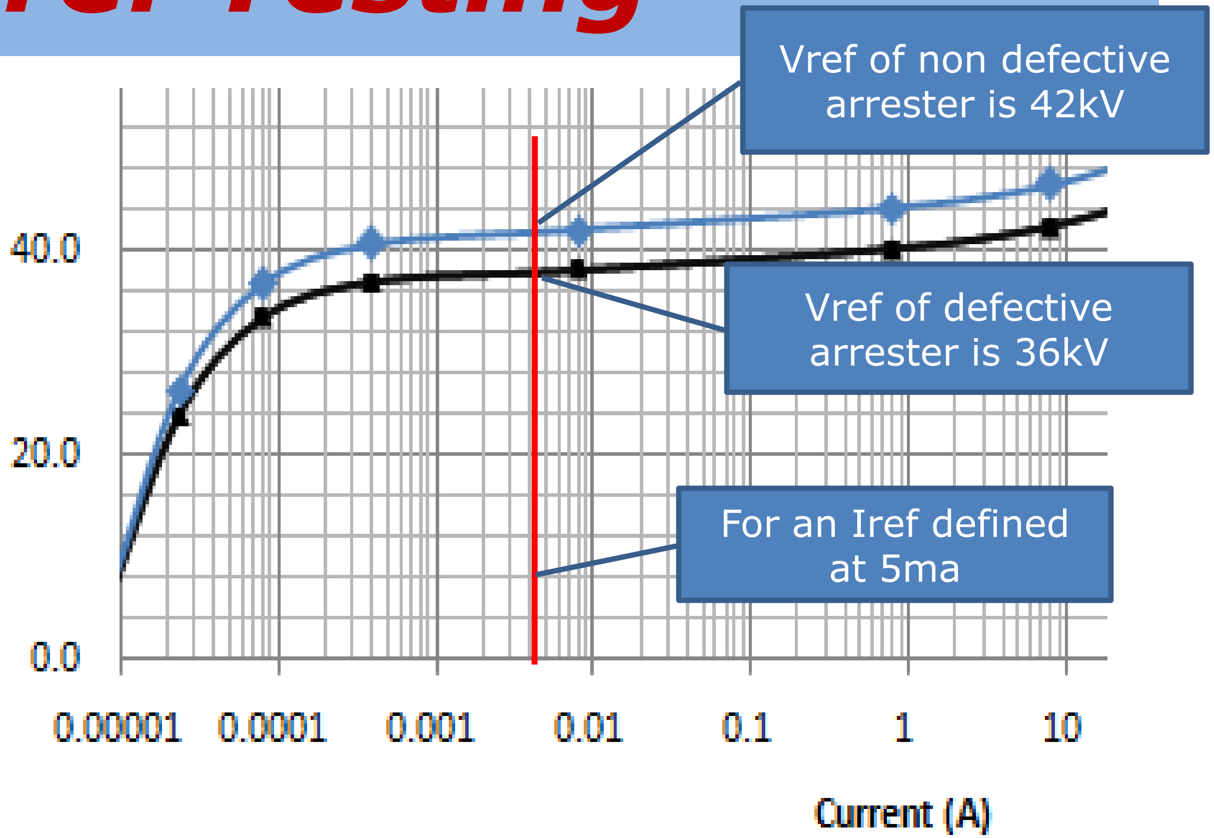


Vref Testing

A sensitive point on the curve regarding any change in character is Vref.

Vref is defined as the voltage measured across the arrester when Iref is applied.

Iref is defined as any reference current applied to a arrester that results in conduction above its capacitive current level



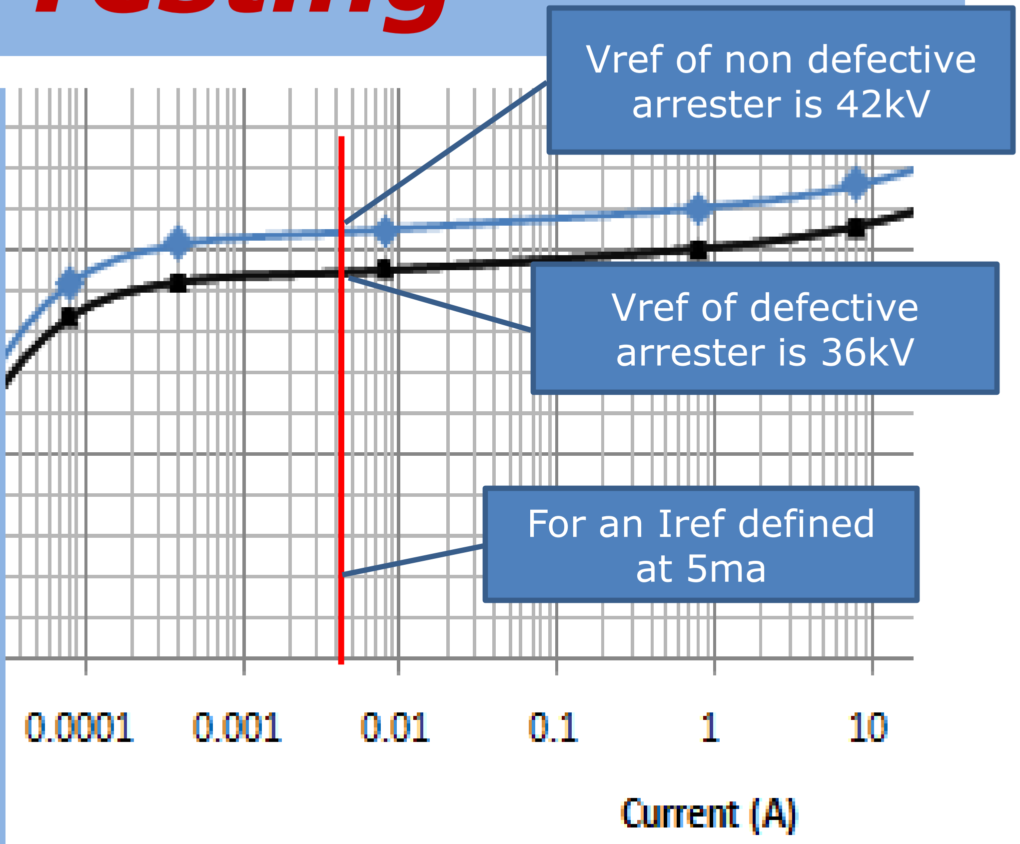
Vref Testing

Measuring Vref is a positive way to determine if an arrester is near end of life..

However
It cannot be done easily while the arrester is on the system.

The arrester must be partially isolated from the circuit to perform this analysis.

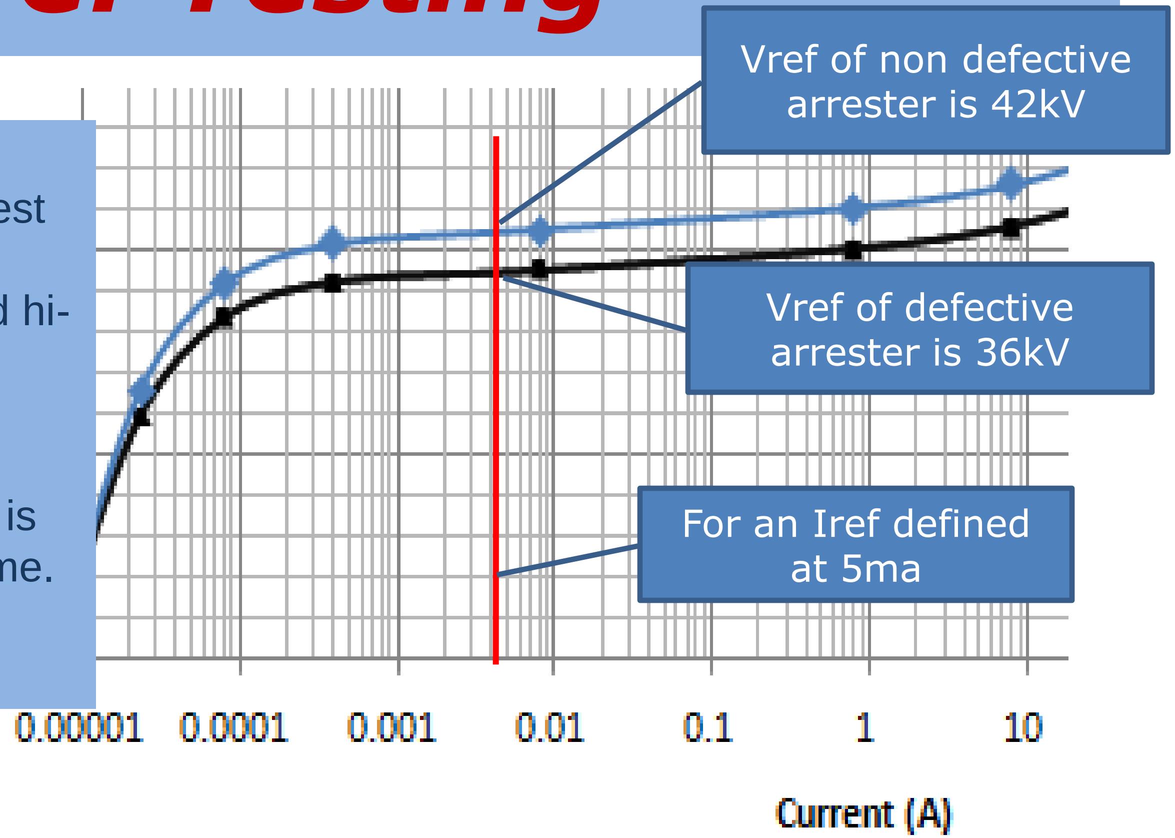
This method also requires that several arresters be tested to set the reference voltage of the non-defective arrester



Vref Testing

A very positive aspect of this test method is that it can be accomplished by using standard hi-pot test equipment.

The value of Iref is not significant, as long as the test is done at the same level each time.

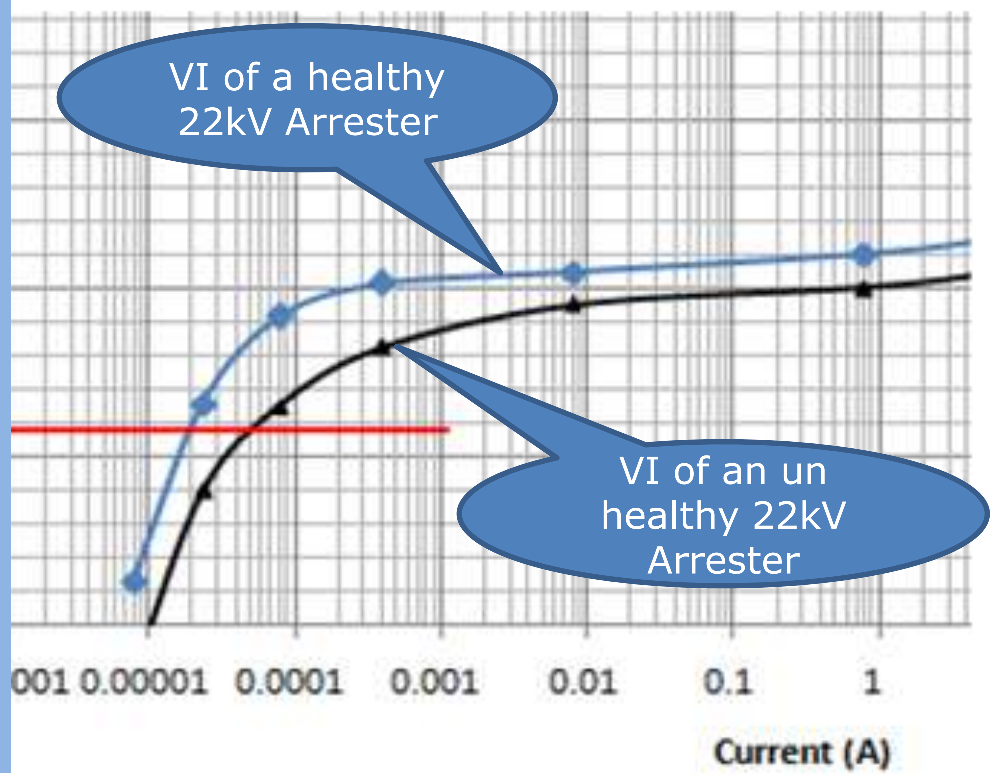


Leakage Current Testing

Arrester Leakage current testing to assess the character of an arrester is by far the most common method used in the industry.

There are several reasons for its popularity.

1. Highly dependable
2. Can be done on line both momentarily and continuously
3. Is cost effective
4. Can be done off line with a separate voltage source

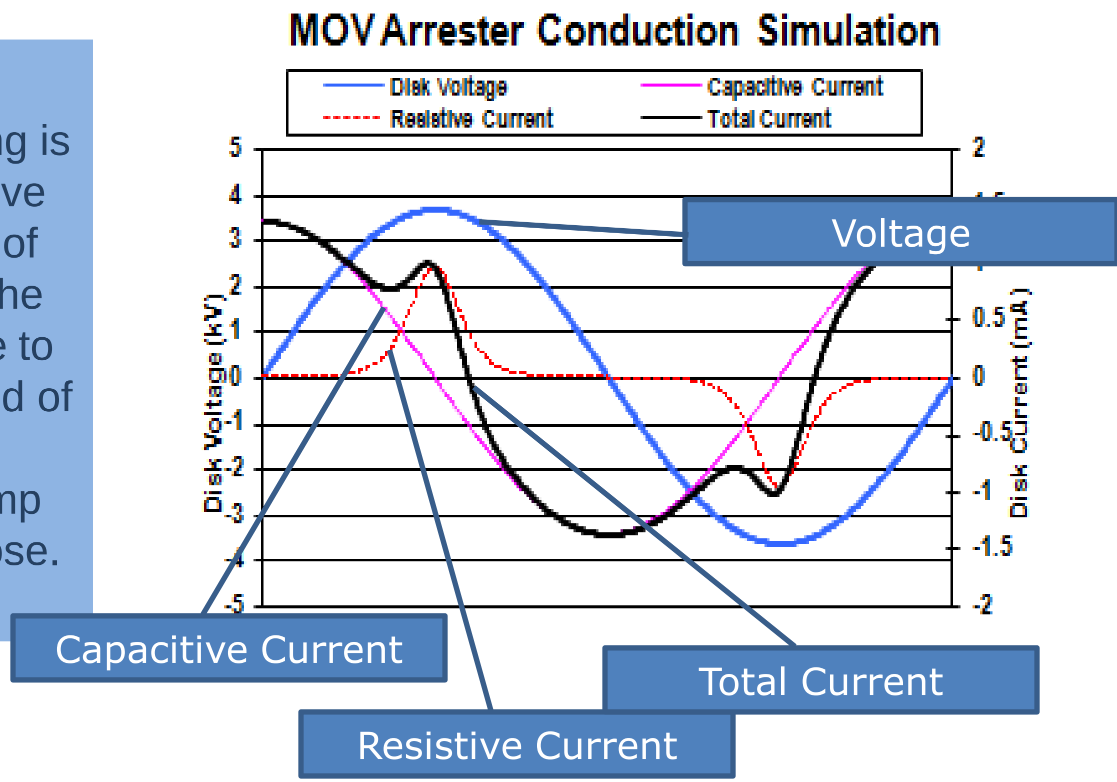


Leakage Current Testing

The Issue

The difficulty of leakage current testing is separating the capacitive and resistive currents. The only leakage current of any value is the resistive current. The capacitive current is quite insensitive to changes in the arrester as it nears end of life.

For this reason, simple clamp-on amp meters cannot be used for this purpose.



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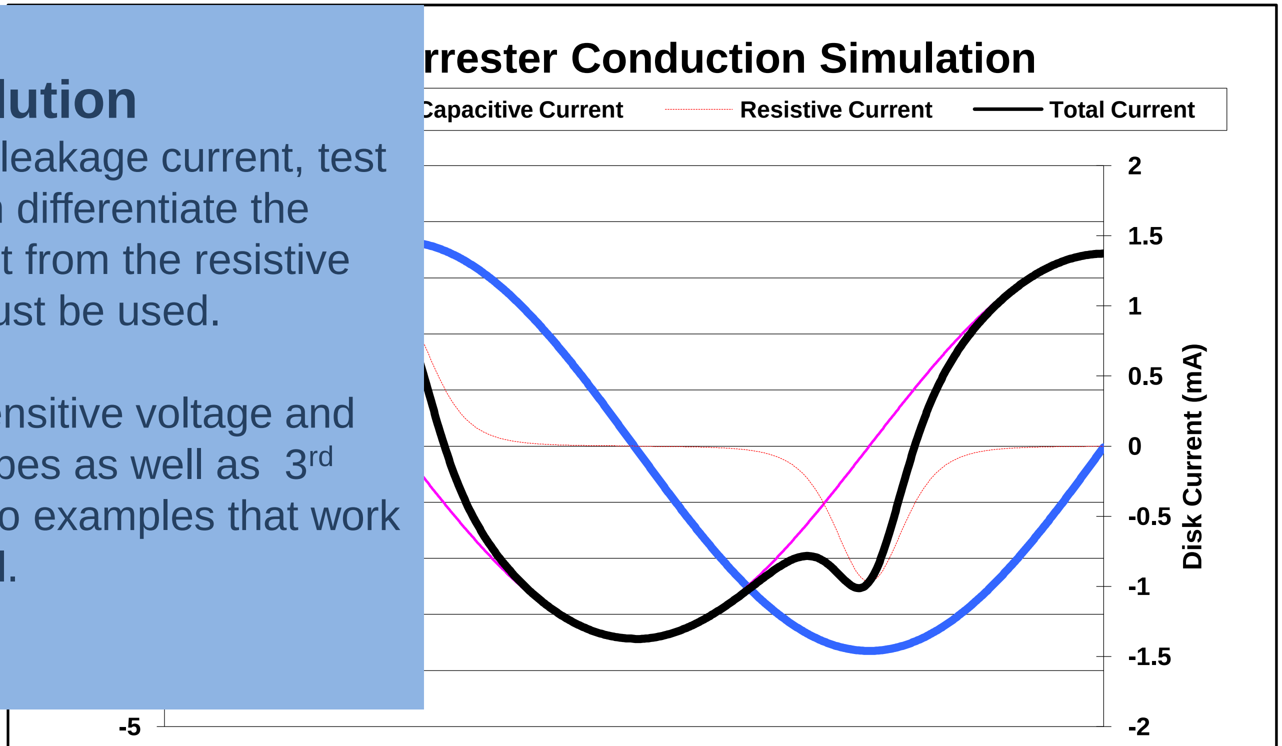
Leakage Current Testing



The Solution

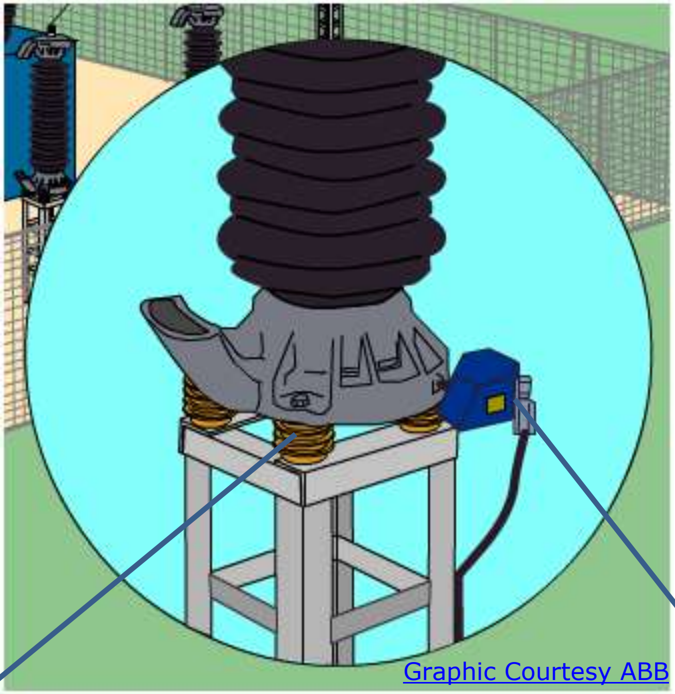
To effectively measure leakage current, test equipment that can differentiate the capacitive component from the resistive component must be used.

Oscilloscopes with sensitive voltage and resistive current probes as well as 3rd harmonic meters are two examples that work well.

Leakage Current Testing

Arrester Base Insulators

Another consideration with leakage current testing is that the arrester current must be guided through a unique ground cable where the current can then be metered. This is done by raising the arrester off of ground with insulators and running the ground lead to the Current monitor



Graphic Courtesy ABB

Watts Loss Measurement

Watts loss measurement of an arrester can be very effective, however very difficult to measure.

Many manufacturers measure watts loss during final production tests since the IEEE standards implies that it be measured. The measurement is generally done near the units MCOV where it is a valid measurement. At any other voltage it is only a relative number.

The problem with all the watts loss meters available for the field is that the maximum voltage used in the test is 10kV. A 10kV watts loss on a 120kV MCOV arrester is not very accurate at best.

Ineffective Arrester Field Tests

It is not recommended that a watts loss measurement of an arrester be used as a reliable means to assess the quality of an arrester without repeating the test many times on many arresters.

The use of a meg-ohm or tera-ohm meters to measure the quality of an arrester under any circumstances is not recommended.

Using a surge counter to assess the quality of an arrester is not recommended under any circumstances.

In Summary

There are several methods for effectively measuring the quality of an arrester in the field.

Thermal testing and leakage current testing are the most reliable and cost effective.

Vref Testing, Watts Loss Testing and Partial Discharge testing can be used, but are difficult and not as cost effective.

Watt Loss Testing, Ohm measurement, and surge counting are not considered effective field testing.

The use of a simple cost effective Infrared Thermometer is the fastest, safest, and most effective means of assessing the status of an arrester in the field.

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Jon Woodworth