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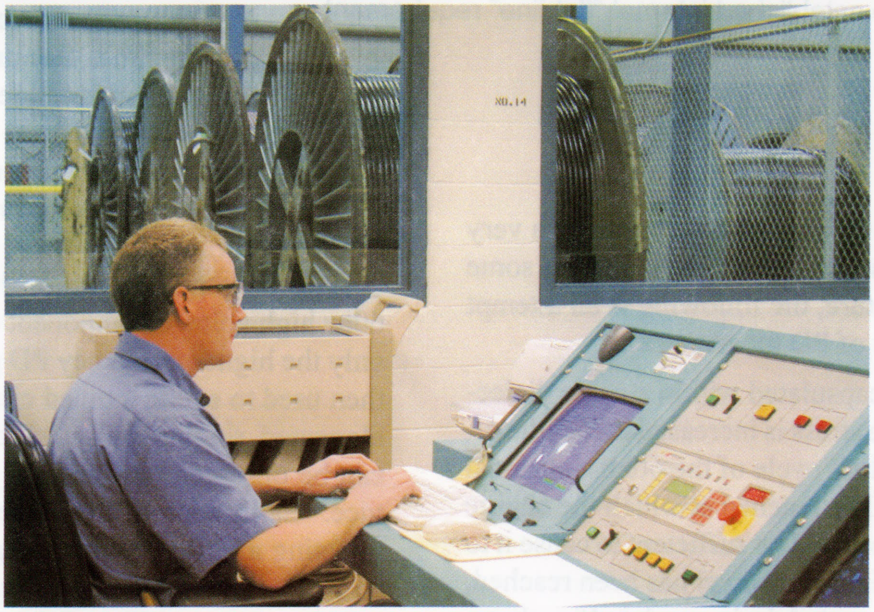
Corona Testing

In North America, "Corona" is often the term given to any type of electrical discharges and is frequently used interchangeably with "Partial Discharge". In Europe, "Corona" is used only to describe external discharges, or those between two uninsulated conductors. Such discharge, where a solid dielectric is not involved, are not typically considered damaging.



Corona Test is performed on a single conductor prior to cabling at Okonite's newly constructed Test Facility at our Orangeburg, SC Cable Plant.

The more precise general term to describe any electrical discharge which only partially bridges the insulating medium between conductors is Partial Discharge. A Partial Discharge (PD) can be any of the following:

- an internal discharge in a cavity within a solid dielectric between two electrodes
- a surface discharge across the surface of a solid dielectric (such as a termination or bushing)
- a corona discharge around an uninsulated conductor

One of the earlier technical papers on the subject of Partial Discharge was "Cable Corona Signals - Their Origin and Detection" by R. B. Blodgett and D. Eigen of Okonite in 1967. The Introduction of this paper sums up the concerns at that time regarding the increased use of solid dielectrics in the industry. The announcement of an October 3rd 1966 meeting (sponsored by the New York Section of the IEEE) on the problem of corona in solid dielectrics said, "The tremendous increase in the use of solid dielectric cable in recent years has not been without problems. Moisture, the chief culprit in paper insulated cable failures, has been replaced by ionization (corona) as the villain in solid dielectric cables. Effective prevention and detection of ionization and it's sources in cables, jackets, joints and terminals is still the subject of much debate and experimentation."

Over the years many advances have been made in the area of PD detection with the introduction of noise rejection techniques, signal processing through the use of digital technology and site location using TDR methodology. With these advances and the significant improvements in the state-of-the-art of cable manufacturing, has also come a steady "ratcheting" down of the allowed PD levels by the industry specifications. The following table is a good illustration of how cable technology has progressed.

Even with all of the advances in PD detection, the basic measuring technique has remained the same.

AEIC Partial Discharge Requirements
Maximum Permissible Discharge
(Picocoulombs)
Stress as a Percent of Rated Voltage to Ground

	150%	200%	250%	300%	400%
1973	5	30	55	80	80
1975	5	20	35	50	—
1981	5	5	5	27.5	50
1983	Okonite established internal "flat-line" requirement				
1987	5	5	5	5	10
1996+	5	5	5	5	5

Though the physics of partial discharge can be a very complex, as becomes obvious when reviewing some of the available literature, the following is an attempt to simplify the basics of PD measurement.

Consider a cavity encapsulated within a cable dielectric. As the ac voltage stress is increased across the dielectric, during each half cycle of the 60hz sinusoidal waveform a level will be reached at which the charge build up within the void will be sufficient to cause it to discharge. Once the initiation level has been reached, this process will be repeated during each half cycle resulting in 120 discharges/second. The level at which PD is first observed is known as the Discharge Inception Voltage (DIV). Obviously if the DIV is below the operating voltage of the cable, a state of constant discharge could exist in service and a failure may be imminent depending on the susceptibility of the dielectric to discharge. As the voltage is decreased, the level at which the PD drops below a specified magnitude (5pc for cable), is known as the Discharge Extinction Voltage (DEV).

Each time a discharge occurs a current flow of significant magnitude results across the cavity. Since the discharge is contained in a confined space, extremely high and intense local heating occurs. This can results in a explosion-like gas expansion at the PD site. These discharges can erode the dielectric, change it's molecular structure and produce as by-products of these processes, materials which were previously not present. These new materials may react with the surroundings causing further degradation of the dielectric. Though PD can be catastrophic to some dielectrics, not all are affected equally. It is well documented that polyethylene based dielectrics are much more susceptible to deterioration due to discharge then an EPR-based material.

A PD pulse has an extremely short duration and rise time. Because of the short duration and small magnitude of these pulses, the actual pulse generated by the discharge is not what is directly observed at the output of the standard PD detector. The detection process begins by first passing these pulses through a high voltage Power Separation Filter which removes the 60hz high voltage component of the signal and leaves only the higher frequency PD pulses. The PD pulse is then used to excite a tuned circuit which produces an elongated ringing pulse which, after amplification, can be observed on the CRT or other indicating device. Calibration of the detector is accomplished by injecting a pulse of know magnitude into the system so that the required measuring sensitivity can be set. AEIC refers to ICEA T-24-380 "Guide for Partial Discharge Test Procedure" regarding the details of the test apparatus and calibration procedure to be used for cable testing.

For cable tests conducted by the manufactures, typically the maximum test voltage is 200volts/mil and as can be seen by the above table, the present standard requires that a discharge level of less then 5 picocoulombs exist at 400% of operating voltage (200volts/mil for a 15kV cable). In reality, the 5 pc minimum level has been determined to be the maximum sensitivity attainable in a typical "noisy" manufacturing plant environment. Under controlled laboratory conditions, much higher sensitivities are certainly possible.

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