Electrical Testing of Prototype Wildlife Guards and Deterrents

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1.0 Introduction/Summary

Mr. Mike Lynch of ECO Electrical Systems Incorporated requested that NEETRAC perform dielectric testing on two wildlife-related products. Testing was performed on cover-up devices designed to prevent electrocution of large birds or other wildlife on distribution structures. Testing was also performed on perching deterrents designed to keep large birds from landing on distribution or transmission crossarms.

No industry standards currently exist for wildlife guards or deterrents. Consequently, there are not requirements for dielectric testing of these devices. To evaluate the dielectric performance, a custom test program was designed. The test program included dry ac withstand, ac flashover, wet ac withstand, and wet visual corona tests.

The testing showed that the guard has a dielectric strength that is appropriate for use on 15kV[1], 25kV[1], and 35kV[1] systems provided that the cap diameter is properly sized for the insulator on which it is installed. Wet corona tests revealed that the arrow-type perching deterrent is superior to the vertical tube-type and that the deterrent should be placed at least three inches from the nearest conductor or insulator skirt to prevent corona discharge.

2.0 Purpose and Scope

The purpose of the project is to assess the dielectric performance and properties of wildlife guards and deterrents. The scope was limited to dielectric testing only.

3.0 Samples

The testing was performed on various implementations of two products designed by ECO Electrical Systems Incorporated. One product, the wildlife guard, is a conductor

[1] Phase-to-Phase RMS

cover designed to reduce outages resulting from wildlife contact at the conductor support insulator. It consists of a PVC cap that covers the energized portion of the insulator, connected to interlocking PVC tubes that extend out over and cover the phase conductor.

The other product was a perching deterrent designed to prevent large birds from landing on the crossarm. The perching deterrent was initially designed as a set of vertically mounted, parallel PVC tubes of various lengths. During testing, the design was changed to an arrowhead configuration to improve leakage and tracking distance over the material surface.

In some cases, the outer surface of the PVC material on the guard or deterrent was coated with a silicone rubber material. This coating serves three purposed:

1. to enhance water repellency,
2. improve surface tracking resistance, and
3. improve resistance to material degradation caused by exposure to ultraviolet light.

Wildlife Guards (Conductor Covers)		
Sample Number	**Cap Size**	**Coating**
1	5"	None
2	5"	None
3	5"	Silicone Coating (Cap Only)
4	6"	Silicone Coating (Entire Sample)
5	4"	Silicone Coating (Entire Sample)

Table 1 - Sample descriptions

4.0 Test Procedure

A dry power frequency withstand test was performed on the wildlife guards. A typical distribution structure was assembled in the test laboratory consisting of a pole, crossarm, brace, and pin-type ceramic insulators. A conductor span of approximately 30 feet was installed and suspended on the insulator. The span was energized using a series resonant ac test set. **Figure 1** shows the overall test configuration with a perching deterrent installed on the crossarm.

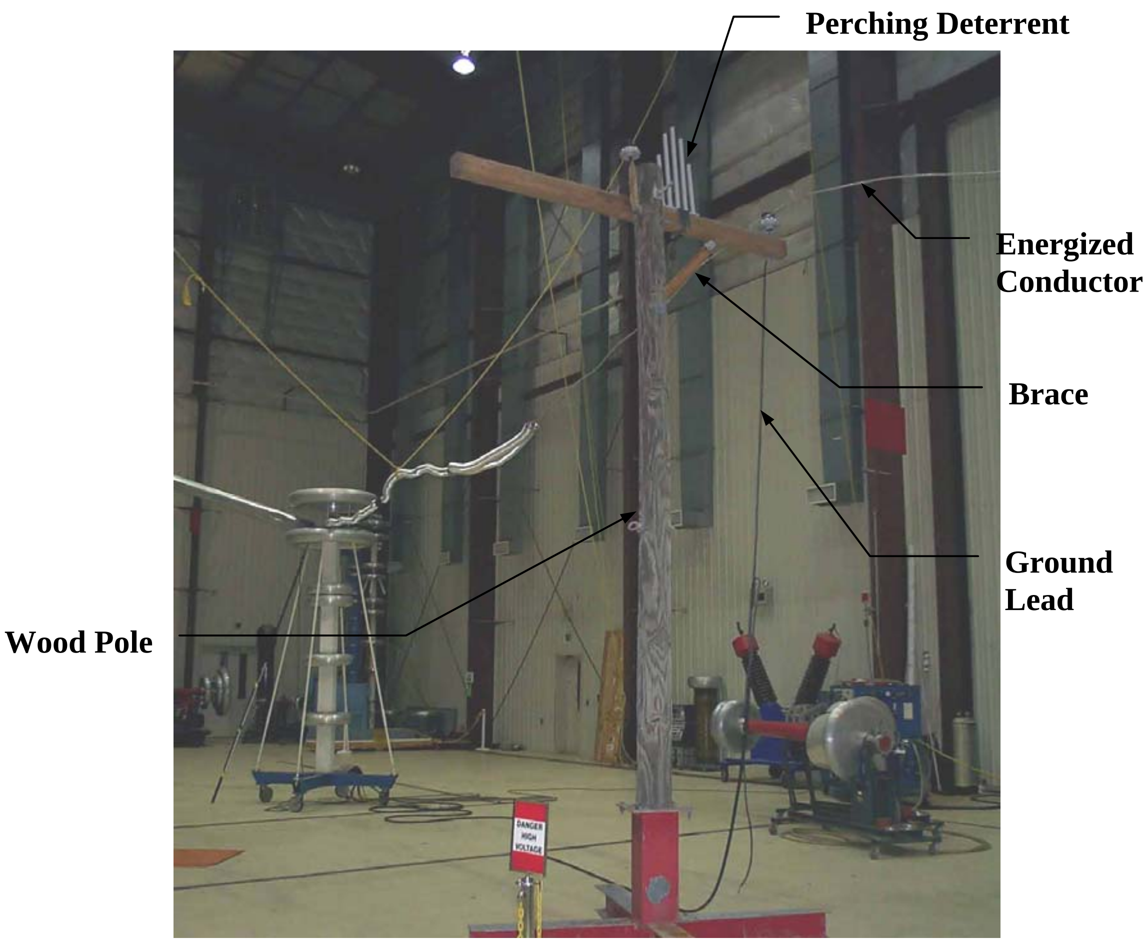

Figure 1 - Test configuration

The wildlife guard (conductor cover) was installed on the energized span. A hot stick with a grounded hook on the end was used to simulate the worst case condition of possible bird or other wildlife contact. The grounded metal hook was placed in direct contact with the guard. The hook was moved over the surface of the guard until all areas were tested except for the last 3 to 6 inches at the outer ends of the conductor tube. Since the impedance of a bird is likely to be much higher than that of the solidly grounded metal hook, the test was more severe than would be expected in case of an actual wildlife contact. The guard passed the test if no disruptive discharge or flashover was observed.

A dry power frequency voltage withstand test was performed in which a copper electrode was installed on the wildlife guard halfway along the tube that covers the conductor. This electrode was grounded while the conductor was energized. The test effectively evaluates the dielectric strength of the material used in the construction of the guard. The guard passes the test if no disruptive discharge (puncture) or flashover is observed during the one minute that voltage is applied to the conductor. **Figure 2** shows the grounded electrode installed on the wildlife guard. The material did not puncture during the test.

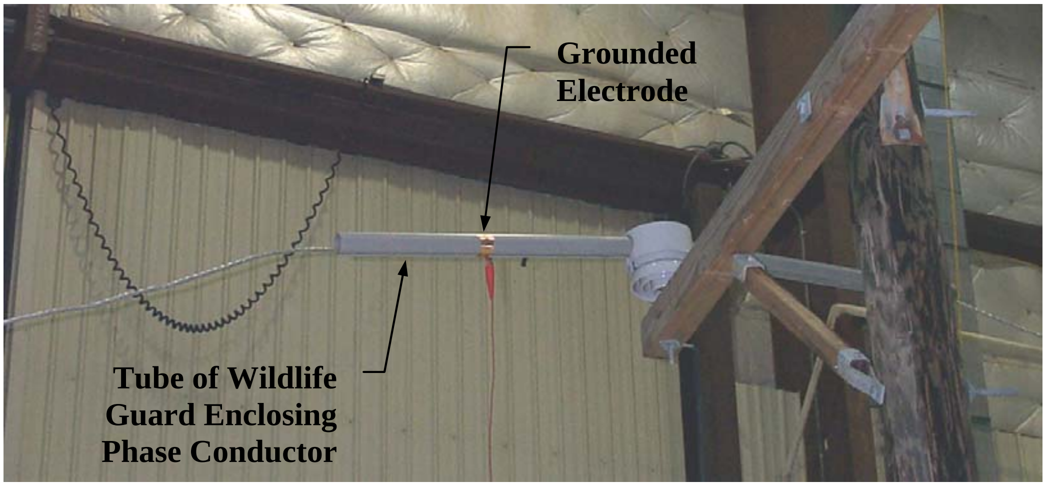

Figure 2 - AC withstand test using grounded electrode

From a dielectric and surface leakage current stand point, wet testing produces some of the most severe test conditions. The conductivity of water in combination with any surface contaminants that may be present can lead to surface tracking, corona discharge, material erosion, and ultimately flashover. To assess the dielectric properties of the perching deterrent under the most severe conditions, a wet corona test was performed. Tap water with a conductivity of 60 Ω-m was sprayed into the gap between the insulator and the perching deterrent. The water spray direction and flow rate were based on the parameters specified in IEEE Standard 4 - 1978. The perching deterrent was mounted to a grounded bracket and installed on the crossarm at various distances from the insulator. The laboratory was darkened and a high gain photo-multiplier type image intensifier used to detect corona on the perching deterrent, insulator, and adjacent structures. **Figure 3** shows the configuration used for the wet corona test as it was being performed on the vertical tube type perching deterrent.

A perching deterrent was considered far enough away from the insulator when no corona was detected on the deterrent and no discharge was detected between the deterrent and insulator skirt using the image intensifier. **Figure 4** shows the same test configuration used for corona testing of the arrow-type perching deterrent under wet conditions.

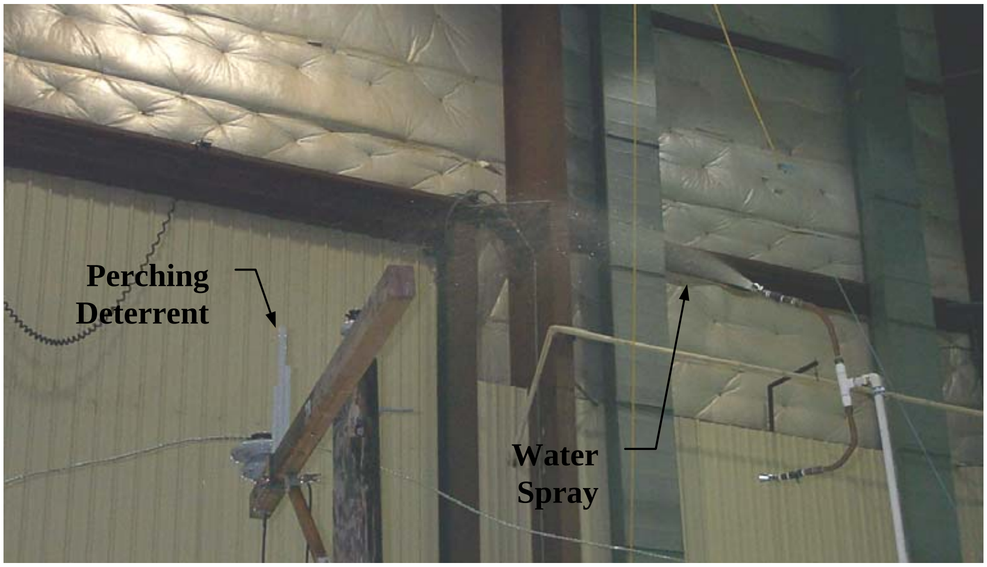

Figure 3 - Wet corona test configuration

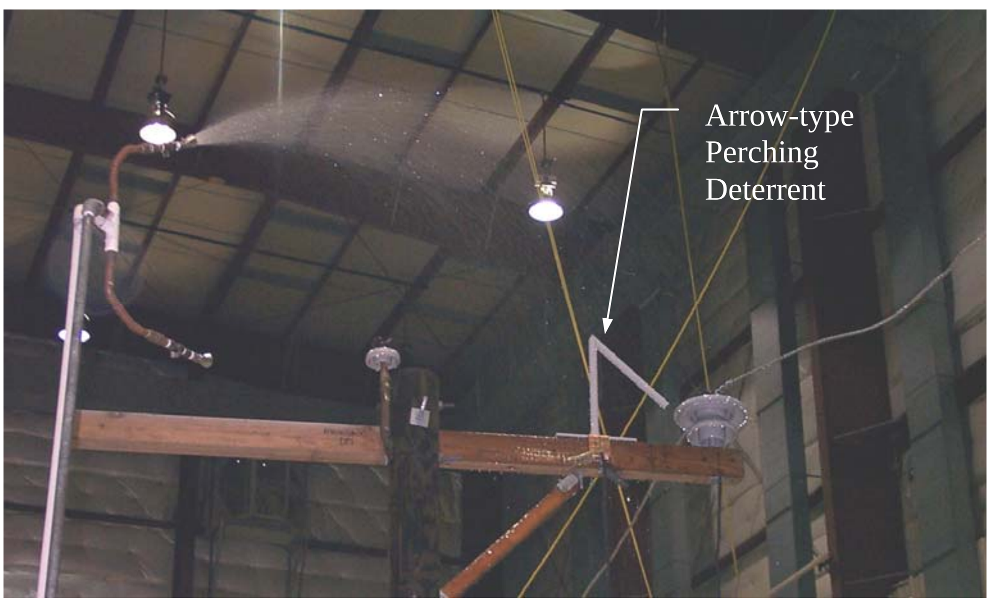

Figure 4 - Arrow type perch deterrent, wet corona test

5.0 Test Results

Table 2 and **Table 3** summarize the testing performed on each sample and the results obtained. Configurations used during the testing are identified.

Wildlife Guard (Conductor Cover) Testing				
Sample Number	**ANSI Insulator Type**	**Test Performed**	**Applied Voltage Phase-to-Ground (kV RMS)**	**Result**
1	55-4	Direct contact with a grounded object. Touched all parts of the wildlife guard with grounded stick.	7.2	No discharge.
			15	Buzzing discharge at the cap/insulator interface.
2	55-6		14.4	No Discharge.
			25	Buzzing discharge on the top of the PVC tubes. Flashover through the tube/cap gap.
4			20	Flashed at the cap/insulator interface. Buzzing discharge on the cap. Flashed through the tube/cap gap.
			35	Buzzing discharge with the grounded stick in close proximity to the guard. Did not proceed with the direct ground contact.
2 w/ neoprene boot	56-3		20	Flashed at the cap/insulator interface.
1	55-4	Water spray with 60 Ω-m water, vertical flow rate of 5 mm/min, 45-degree spray angle. Direct contact with a grounded object. Touched all parts of the wildlife guard with grounded stick.	15	No Discharge.
3	55-5	Grounded electrode placed around PVC tube midway between the bare conductor and the insulator cap. 1-minute ac withstand test.	25	Flashed over at 23kV. Tracked surface (no puncture).
None	55-5	ANSI C29.1 Dry Flashover Test		71.3 kV average flashover value.
3	55-5	ANSI C29.1 Dry Flashover Test		72.0 kV average flashover value.

Table 2 – Wildlife Guard (Conductor Cover) Test Results

Perching Deterrent Test					
Sample Description	**ANSI Insulator Type**	**Conductor -to- Deterrent Distance**	**Test Performed**	**Applied Voltage Phase-to-Ground (kV RMS)**	**Result**
3 vertical tubes, conductive mounting bracket	56-3	8.25"	Water spray with 60 Ω-m water, vertical flow rate of 5 mm/min, 45-degree spray angle. Observed corona discharge using light amplificatio n device.	35	No discharge.
		6.5"		20	No discharge.
				35	Periodic discharge from insulator shed to closest vertical PVC tube.
5 vertical tubes, silicone coating, conductive mounting bracket					Continuous scintillation along the vertical PVC tubes, especially those closest to the insulator.
Removed two of the inner tubes (2 & 4 of 5).					Same result.
Added Semi-conducting tape to the inside of the tube closest to the insulator					No scintillation, occasional discharge from insulator shed to closest vertical PVC tube.
		7.25"			No discharge.
Removed semi-conducting tape.	55-6	4"		25	Periodic discharge from insulator shed to closest vertical PVC tube.
	55-4	4.25"		15	No discharge.
				25	Minor scintillation on the tube closest to the insulator.
3 vertical tubes, conductive mounting bracket				15	No Discharge
				25	No Discharge
Arrow-head design with silicone coating	55-5	3"			No Discharge
		1" to insulator skirt		35	Scintillation on vertical PVC tubes. Occasional discharge between insulator shed and deterrent.
		5.5" to conductor, 2.5" from insulator skirt		35	Scintillation on vertical PVC tubes.

Table 3 - Perching Deterrent Test Results

6.0 Conclusions

Wildlife Guard (Conductor Cover)

Two questions were addressed by this testing:

- Will the cover reduce wildlife electrocutions?
- Will the cover affect the existing insulation value of the structure?

By placing a grounded object in direct contact with the conductor cover and adjacent areas, a worst-case scenario was produced that represented possible wildlife contact in and around the area of the pole crossarm and insulators. Since no flashovers were observed at test voltages below 15kV[2], it would be nearly impossible for a bird to cause a flashover at system voltages below 25kV[3]. At system voltages higher than 25kV[3], a bird could possibly cause a flashover by contacting the tube/cap gap or the cap/insulator interface. Sealing of the tube to cap interface should improve the performance of the wildlife guard. Performance can be improved at the cap/insulator interface by properly sizing the cap to cover and extend beyond the edge of the semiconductive glaze surrounding the neck of the insulator. These changes will raise the useful range of the design to cover 35kV[4] rated systems.

In order to address the second question, the dry, low frequency flashover test specified by ANSI C29.1 was performed on an insulator both with and without the wildlife guard (conductor cover). The difference between the two flashover values was not statistically significant, indicating that the cover had no effect on the existing insulation value of the structure.

Perching Deterrent

The main concerns identified with respect to the perching deterrent were:

1. whether it would decrease the dielectric withstand capability of the insulator as it was brought into close proximity of the insulator and

[2] Phase-to-Ground RMS
[3] Phase-to-Phase RMS
[4] Phase-to-Phase RMS

2. whether it would be susceptible to surface tracking caused by the high electric field gradients near the insulator.

Both questions are related to the distance that the deterrent can be placed from the insulator without jeopardizing the existing insulation of the structure.

The testing revealed that the arrowhead design provides superior dielectric performance when compared to the vertical tube design. During wet testing, a scintillation effect was noted on the silicone rubber coated vertical tube deterrent. No similar effect was noted on the uncoated deterrent. The hydrophobic characteristics of the coating, coupled with the intense electric field near the insulator, caused water droplets on the surface of the tube to accumulate charge. Once the accumulated charge reached a threshold, a discharge occurred to the adjacent water droplets, producing a scintillation effect. Testing also revealed that placing the deterrent too close to the insulator causes discharge from the insulator to the deterrent. Such discharge can produce material erosion and tracking that will ultimately destroy the deterrent. The National Electric Safety Code (NESC) clearances were determined to provide sufficient spacing to prevent discharge to the vertical tube design. To prevent discharge on the arrowhead design, the installation must ensure spacing of at least three inches from the insulator and conductor at system voltages up to 35kV[3]. The extra surface tracking distance and spacing to ground provided by the arrowhead design improve dielectric performance by reducing electric field stress across the surface of the deterrent.