



## Comparison Of *StaClean*<sup>™</sup> With Other Insulator Coatings

E. Robert Perry PE, BS, MS

There are three types of anti-contamination coatings presently offered to the utility industry for application to insulators:

1. Silicone grease
2. RTV Silicone rubber, and
3. Fluorourethane/silicone

The silicone grease is a temporary coating, which requires frequent renewals. It is the only coating presently available which can be applied to insulators while the lines are energized. Both, the silicone rubber and the fluorourethane are considered “*permanent*” coatings. The RTV silicone rubber must be applied as a thick coating to provide a reservoir for the silicone oil that migrates to the surface, providing hydrophobicity (non-wetting) properties. The Fluorourethane coating is applied in a thin coat and depends on the molecular (fluorocarbon and silicone) structure for its hydrophobicity.

### **Background**

Until the 1960’s, the only way to effectively fight pollution on electrical insulators was to wash the insulators frequently, based on observation and weather cycles. In the early 1960’s, silicone grease was introduced to the industry, which had very good hydrophobic (non-wetting) properties. Application of the silicone grease reduced the frequency of the washing cycle for a number of environmental pollution problems. Cost was reduced in most instances compared to washing.

Some problems were experienced with the silicone grease in high dust areas where the dry pollutants formed a crust on the silicone grease, resulting in the performance of the insulators below those of an uncoated insulator. In more moist areas, the silicone grease was suitable for protection up to two years, which was an improvement over washing. In other areas, the silicone grease had to be replaced every six months.

### **Silicone RTV Rubber**

In the 1970's, Dow Corning introduced an RTV silicone rubber coating for insulators; *Sylgard*<sup>TM</sup>. This coating was a standard silicone rubber with aluminum trihydrate, added to provide anti-tracking properties for electrical applications. The silicone rubber used for this application was a silicone rubber with un-reacted silicone oil in the body of the silicone rubber.

The RTV silicone rubber was an effective hydrophobic (nonwetting) coating for insulators. Early tests were conducted in the mid 1970's at Pacific Gas & Electric's Moss Landing Test Station. This was a very foggy environment with little rain and even less sunshine. The test results were positive, and the RTV silicone rubber (*Sylgard*) was considered ready for the market. The coating at this time only required a single coat and no requirement was made on thickness. This is the installation often referred to by the manufacturer to suggest RTV silicone rubber has an extended life capability.

In 1983, Dow Corning experienced a devastating explosion in their silicone rubber manufacturing plant. In restoring the plant, the process of manufacturing the silicone rubber was changed slightly. This change in processing affected the porosity of the silicone rubber, increasing the pore sizes in the material. The increase in pore size of the silicone rubber allowed the silicone oil in the rubber to migrate to the surface much more rapidly. While this temporarily improved the hydrophobicity of the silicone rubber surface, but it also more rapidly depleted the oil available in the silicone rubber body.

It was soon learned the life of this new silicone rubber insulator coating was significantly shortened by the larger pore sizes. The manufacturer recommended the application procedure for applying the RTV silicone be changed to three to five coats, fifteen minutes apart, and the final thickness to be a minimum of 0.020" (20 mil or 0.5 mm). This was necessary in order to achieve a reasonable effective life expectancy of the coating on an insulator.

Studies conducted at the University of Windsor in Canada and presented in technical paper "*Hydrophobic Behavior of Insulators Coated with RTV Rubber*" by Seog-Hyeon Kim and Edward A. Cherney before the 3<sup>rd</sup> International Conference on Properties and Applications of Dielectric Materials reported the silicone rubber lost its hydrophobicity after being wetted by rain, and required 24 hours for the hydrophobicity to be restored to the insulator surface. This has led many utilities to question the performance of the coating when it is most needed.

### **Fluorourethane/Silicone (StaClean<sup>TM</sup>)**

The fluorourethane material was originated by the U.S. Naval Research Laboratories (NRL) in the early 1970's. It was a combination of a fluorocarbon (Teflon) molecule with a urethane molecule. The material was unique in that it provided a surface with approximately the same coefficient of friction as the Teflon, was hydrophobic, UV resistant, and at the same time provided an abrasion resistance four times that of Teflon.

The fluorourethane was originally tested on several ship hulls for the U.S. Navy. One boat tested was a harbor tugboat in Chesapeake Bay. The coating lasted 11<sup>1</sup>/<sub>2</sub> years compared to a conventional hull coating which lasted only 18-24 months. Of major interest was the fact that no rust or corrosion occurred under the coating and biofouling, such as barnacles, could be removed with a high-pressure water jet, rather than chipping or shot blasting.

Mr. Perry, as a Director, Electric Power Research Institute (EPRI), was engaged in cooperative research programs with NRL and foresaw the possible use of the coating in the electric power field. The first application was to coat the conductors on a 230KV line in the U.S. Midwest in an attempt to prevent icing of the conductors and subsequent "galloping" of the conductors. Ice did form on the conductors, but as galloping began, the ice adhesion was low and broke off of the conductor. The next use by EPRI was to coat a number of outdoor disconnect switches in an attempt to reduce the force required to open and close the disconnect switches under 1/2" of ice. The coating provided a 60% reduction in opening and closing effort of the switches (15KV and 230KV switch).

The fluorourethane was originally manufactured by NRL for test purposes and was not available commercially. This was rectified when Allied Signal began to produce the material in 1978. The market was limited as Allied was selling the fluorourethane at \$2,200.00/gallon, which was excessive.

In 1983, Polytech Services had formulated the coating specifically for electrical applications, and began to apply the fluorourethane to the surface of electrical insulators. The material was sold under the trade name of *StaNClean*<sup>TM</sup>. Its slick surface reduced the amount of pollutants that accumulated on the insulator surface and the hydrophobicity prevented the surface from wetting. The *StaNClean* could easily be washed by light rains or winds, preventing an accumulation of pollutants over a period of time.

The economics of the *StaNClean* became evident immediately. Only a single thin coating of the material was required, as the effective characteristics of the material was built into the molecule and did not depend on the thickness of the material for longevity. Even though the *StaNClean* sold near the equivalent price of the RTV silicone rubber, it would coat ten times the number of insulators per gallon as the RTV.

Application of the *StaNClean* to insulators has become worldwide and it is applied in every conceivable type of polluted environments. After eleven years of field applications, there is no indication the *StaNClean* is deteriorating. Laboratory tests indicate a life of 20-30 years. If and when the *StaNClean* should lose its effectiveness, a new coat of *StaNClean* can be applied over the original coat with simple cleaning off the original coat with alcohol.

The *StaNClean* fluorourethane, with slight variations in formulation is presently being used to improve the efficiency of large power producing windmills, large fan blades in cooling towers, boat hulls to prevent biofouling and for ice release on a multitude of applications, including outdoor disconnect switches.

## COMPARISON OF StaClean™ AND RTV Rubber

	<u>StaClean™</u>	<u>RTV Rubber</u>
Hydrophobicity (new)	Excellent	Excellent
Hydrophobicity (after rain)	Excellent	Poor
Dielectric Strength	Excellent	Excellent
Chemical Resistance	Excellent	Excellent
Life Expectancy	15-20 years	3-5 years
Coverage per Gallon	400 ft <sup>2</sup>	40 ft <sup>2</sup>
Coats Required	1	3 - 5
Surface Slickness	Excellent	Poor
Can be Recoated	yes	no