Development of Simple Diagnostic Tool for Detecting Insulators With Contamination Problems

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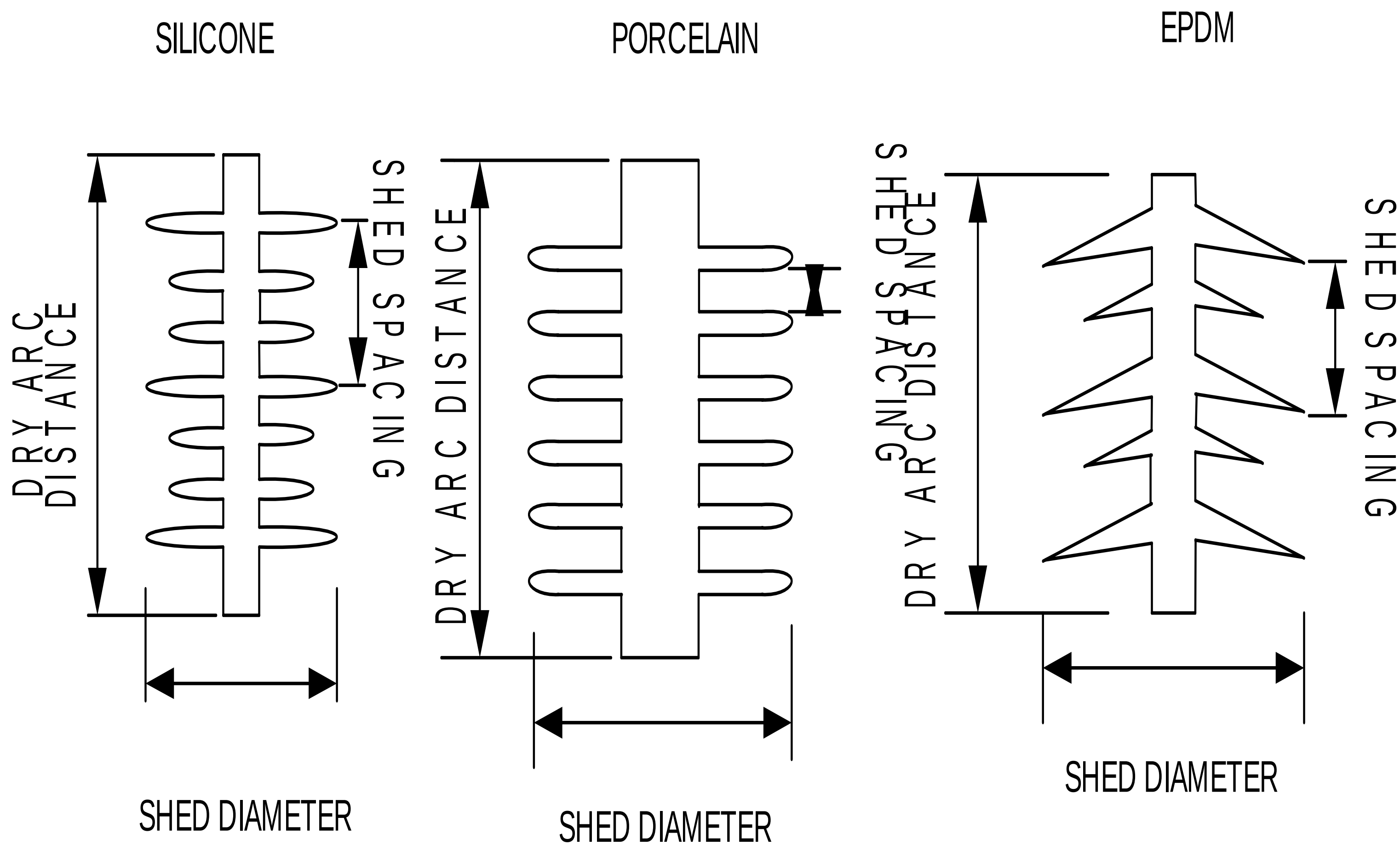
Background

- Electric utilities have numerous sources of insulator contamination including steel mills, freeway salts, diesel fumes, etc.
- It is important to quantify the amount of contamination to determine the severity posed by each kind (variations in conductivity and solubility).
- The critical level of contamination build-up that can be withstood could be different depending on the location.
- In particular, flashovers at fairly low levels of contamination (<0.05 mg/cm2) under ice and melting snow conditions can cause flashovers across insulators and result in customer outages.
- Flashover can result in an arc that starts the pole ablaze.
- A simple method of predicting such events before it is too late is needed
- We propose a combination of field monitoring and laboratory experiments so that more intelligent decisions can be made on preventative maintenance

Insulators Evaluated



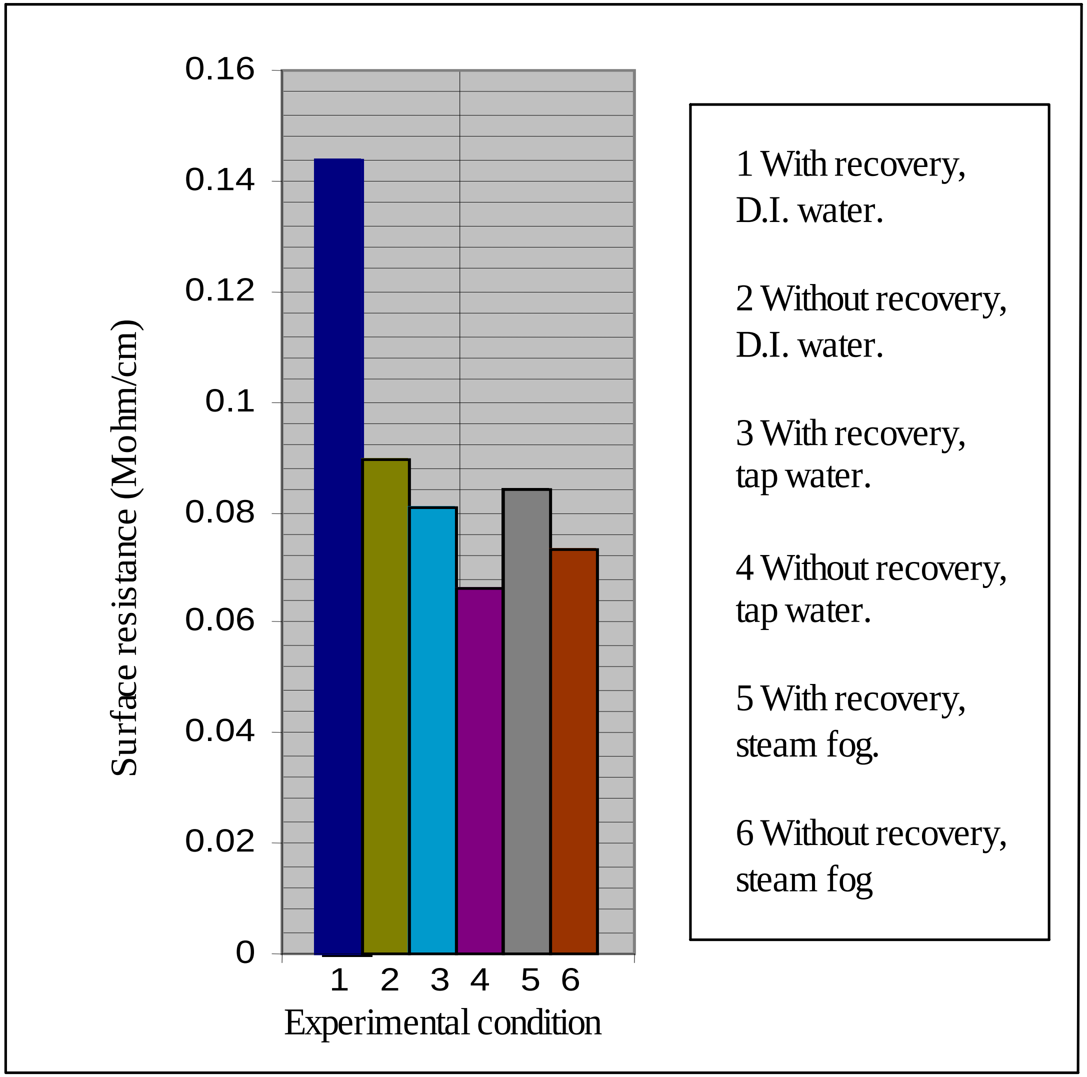
Insulator Dimensions

Insulator	**Dry arc distance**	**Leakage distance**	**Shed dia**	**Shed spacing**
Silicone	330 mm	800 mm	140 mm	105 mm
EPDM	313 mm	713 mm	158 mm	88 mm
Porcelain	350 mm	988mm	213 mm	25 mm

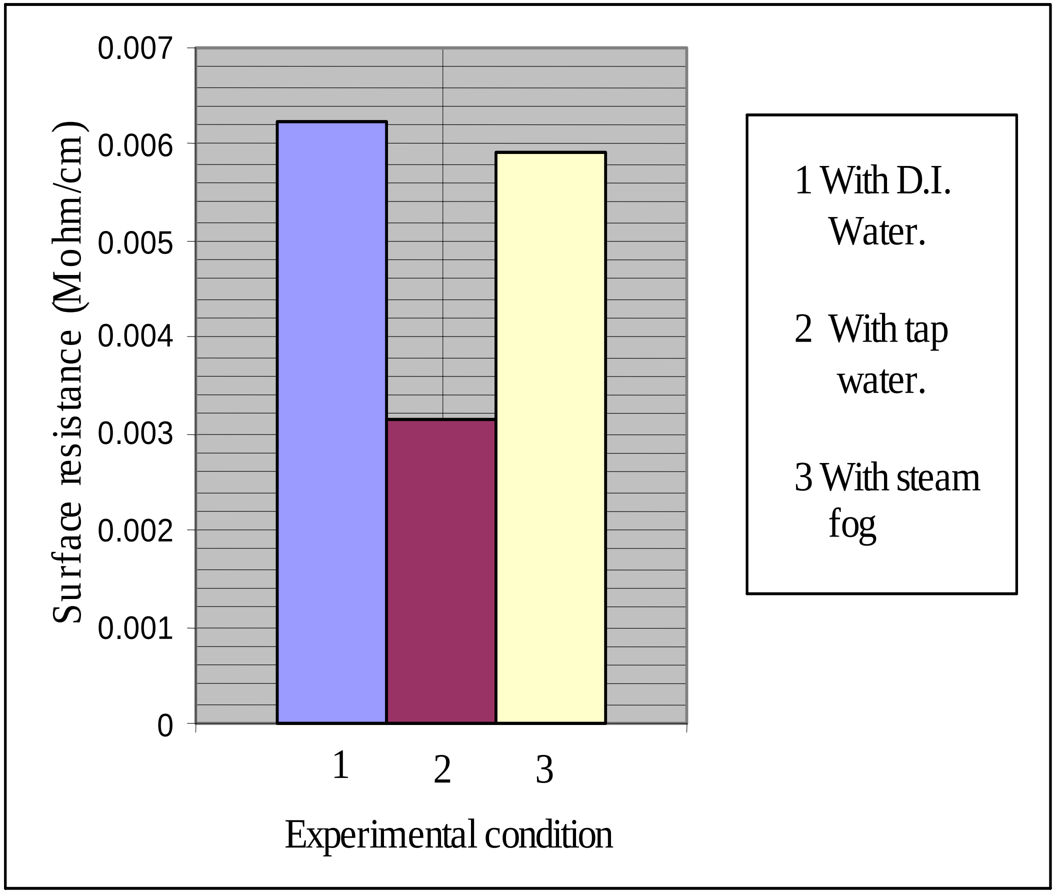
Critical Contamination Levels

Insulator	Recovery	Wetting mode	Conductivity /ESDD
Porcelain		Salt-fog	3 mS/cm
		Steam fog	0.38 mg/cm^2
	Not applicable	Ultrasonictap water	0.19mg/cm^2
		UltrasonicDI water	0.26 mg/cm^2
Silicone		Salt-fog	7 mS/cm
		Steam fog	0.62 mg/cm^2
	No recovery	Ultrasonictap water	0.24mg/cm^2
		UltrasonicDI water	0.32 mg/cm^2
Silicone		Salt-fog	8.5 mS/cm
		Steam fog	0.82mg/cm^2
	Partial recovery	Ultrasonictap water	0.32 mg/cm^2
		Ultrasonic DI water	0.6 mg/cm^2
EPDM		Salt-fog	5 mS/cm
		Steam fog	0.52 mg/cm^2
	Not applicable	Ultrasonictap water	0.28 mg/cm^2
		UltrasonicDI water	0.42 mg/cm^2

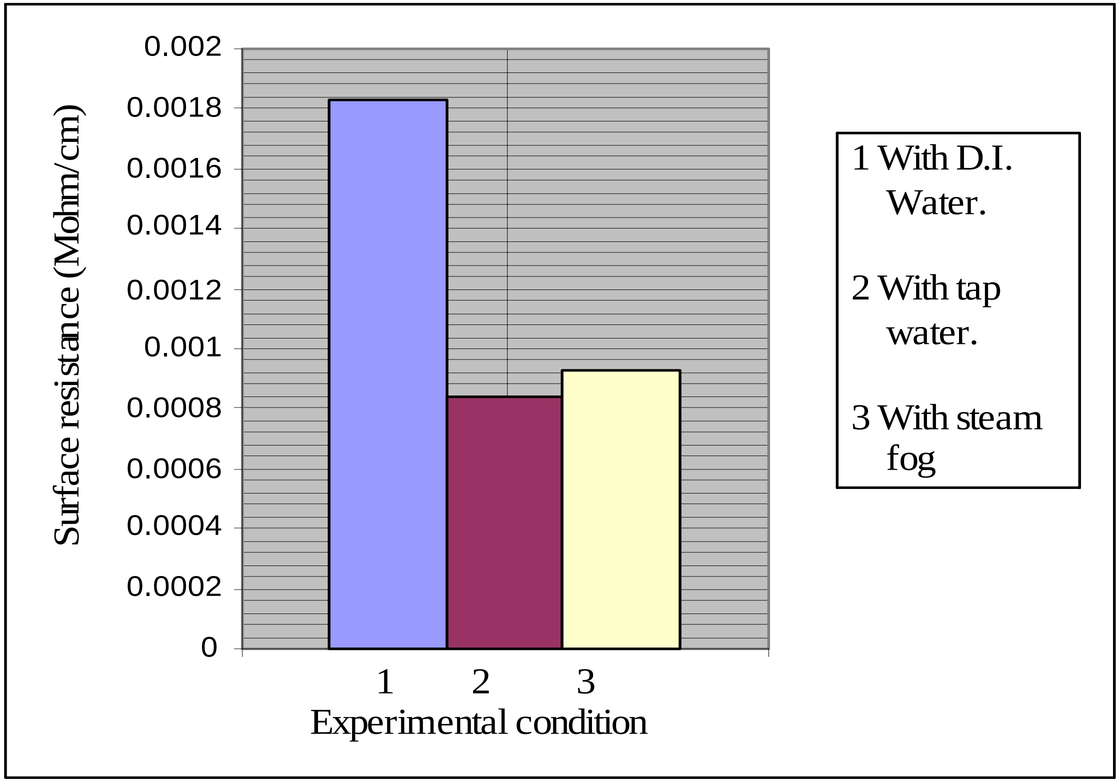
Critical Surface resistance for SR



Critical Surface Resistance for EPDM



Critical Surface Resistance for Porcelain



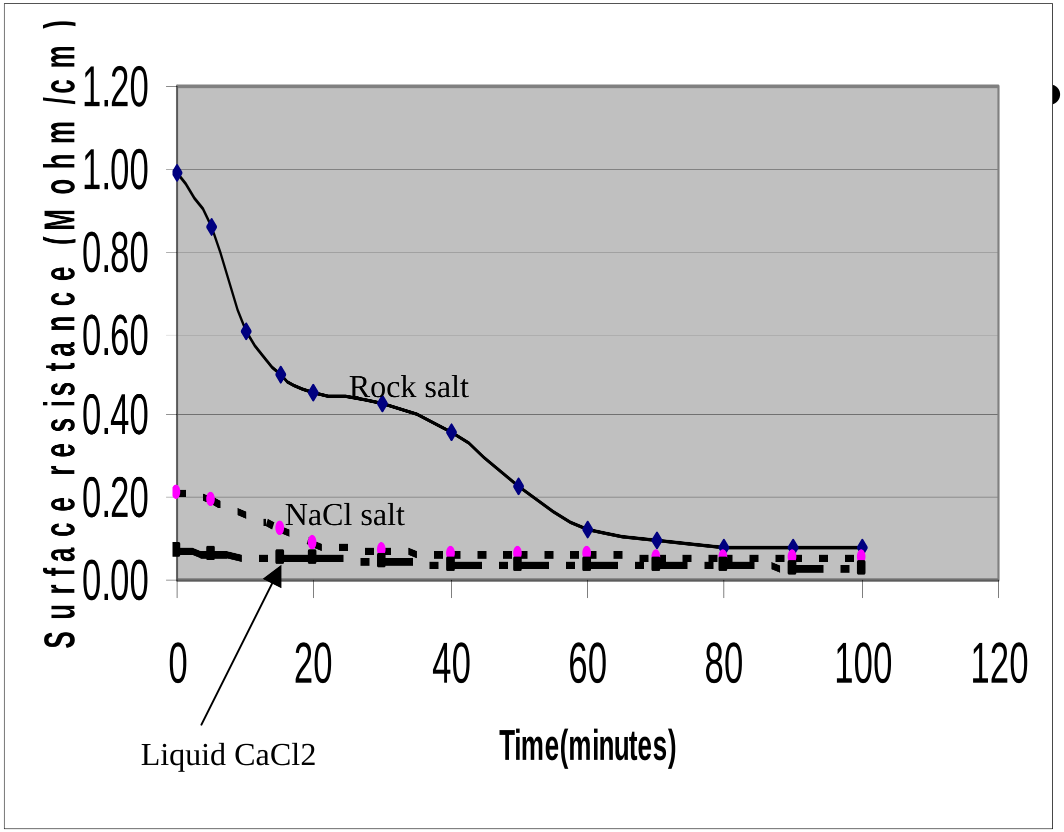
Minimum surface resistance of insulators removed from the field under ultrasonic fog with tap water

Insulator	Surface resistance (MΩ/cm)	Ratio of resistance as-received/critical
Silicone A	0.23	2.8
Silicone B	0.62	7.5
Silicone C	0.56	7
Silicone E	3.93	47
Silicone F	1.83	22
Silicone G	1.07	13
Silicone H	1.37	17
Silicone J	2.03	24
EPDM	0.08	24
Porcelain	0.05	62
Silicone I	1.58	19

Differences in Road Salt Used Presently

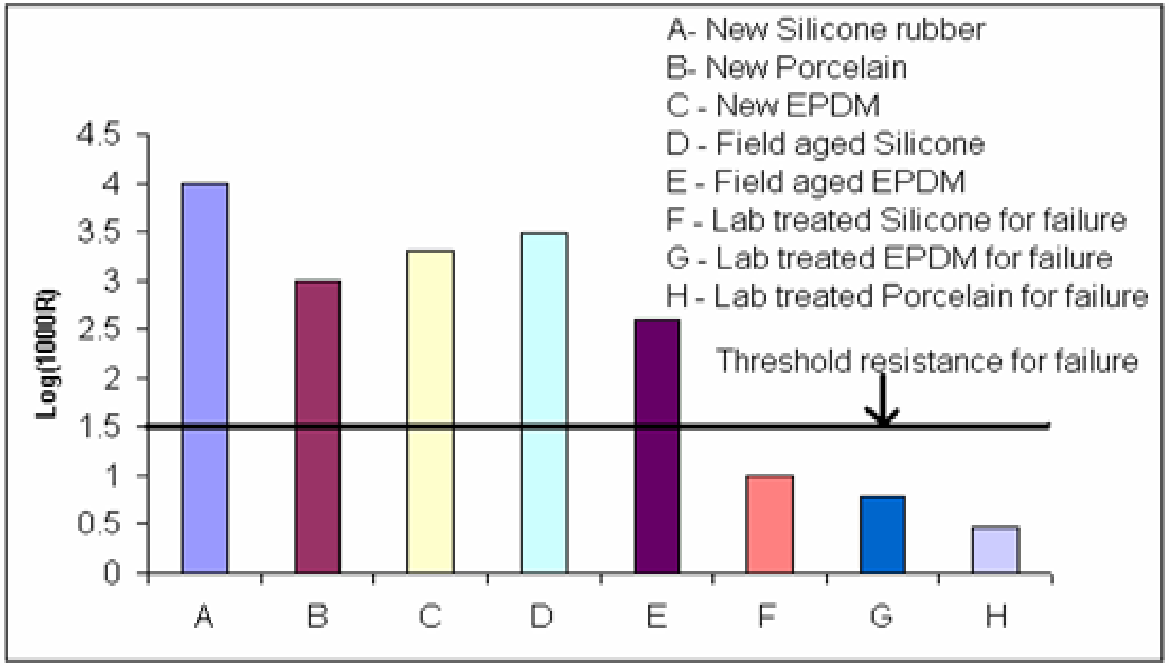
- Rock Salt is commonly used
- Liquid calcium chloride recently used and very popular as it lasts longer on roads
- Magnesium chloride is also used by some
- These salts have different solubilities and adhesion to insulator surface
- Project will evaluate differences in flashover performance

Initial Results



- Faster dissolution will permit flashover to occur with greater ease and with little wetting, such as in light mist or fog

Critical Surface Resistance for flashover



Proposed Methodology

- The project will initially deal with porcelain insulators.
- Dummy insulators” will be installed at various locations on the distribution system along with simple shape devices such as porcelain tiles or discs so that contamination build up can be acquired.
- ASU will use the contaminated samples from the field to develop a diagnostic tool that can easily measure surface resistance.
- The diagnostic tool will allow a field crew to quickly and easily assess the level of insulator contamination in the field.

Methodology (Con't)

- A literature search summarizing the work practices adopted by utilities in maintaining (most washing) their lines. What kind of data do utilities monitor that help them decide when to wash (ESDD, leakage current, dust deposit gauges, experience, monitoring weather conditions, etc). How effective is live-line washing when compared to de-energized washing? how many utilities do live-line vs. de-energized? are these criteria dependent on the nature (chemical make-up) of contamination.
- Place dummy insulators and simple shape devices at various locations on the distribution system to begin field contamination phase.
- Develop and test simple diagnostic tool for contamination detection.
- Perform field measurements with diagnostic tools and compare accuracy with ESDD method on contamination assessment.
- Provide a detailed report summarizing the results of the project

Benefit Summary

- A simple diagnostic tool and method will help utilities cost effectively monitor critical portions of their electric distribution infrastructure for insulator contamination so that they can make better decisions on preventive maintenance needs.