Study Committee B2

Overhead Lines

10278_2022

Silicone coated glass insulators and their application at the PG&E Diablo Canyon Nuclear Power Plant

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Motivation

- Heavy salt fog off the California coast was creating a pollution layer on the surface of porcelain insulators on the 500kV lines at PG&E's Diablo Canyon Nuclear Power Plant (DCPP) (Figure 1). The conductivity of the pollution required a program of live line washing inside the plant of up to 6 times per year to reduce the risk of flashover and generation loss
- Live line washing became a tedious and disruptive task at the plant. Equipment damage and personal injury were also at risk
- Dryer winters in California due to climate change has reduced the opportunities for natural washing from rain
- This study was to evaluate other insulation options in this harsh environment

Figure 1: Diablo Canyon Nuclear Power Plant located directly on the Pacific coast in Avila Beach, CA

Method/Approach

- Equivalent Salt Deposit Density (ESDD) from the porcelain insulators (Figure 2) was measured and reported at very high levels above 1mg /cm^2 which is largely above the "very heavy" classification of IEC TS60815-1 (Figure 3).
- Two approaches were considered to mitigate the rising leakage currents of the insulator strings. First was to increase the leakage distance without increasing the length of the string. The second was to apply silicone coating to the insulator shell to provide a hydrophobic surface on the dielectric (Figure 5).

Figure 2: Porcelain dead end insulators washed regularly

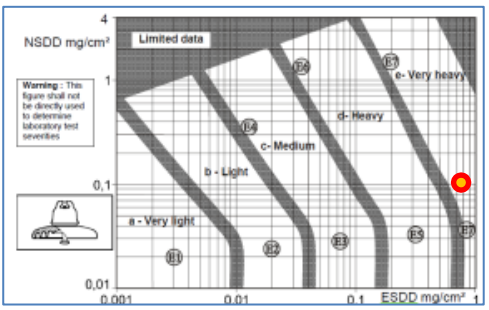

Figure 3: ESDD levels reported at DCPP in the "very heavy" range

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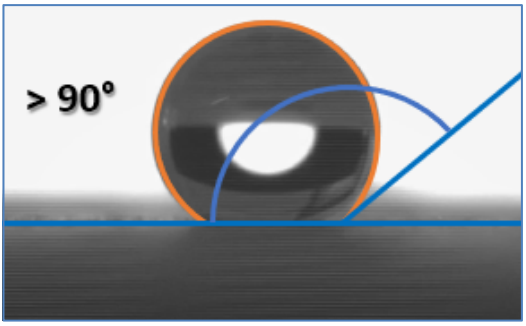

Figure 4: Hydrophobicity when droplet contact angle > 90 degrees

Figure 5: Hydrophobicity maintained after 20 years

Objects of investigation

- The geometry of the insulator shell plays a significant role of an insulator's performance in different environments (Figure 6). For example, toughened glass insulators with a fog type profile could increase the leakage distance of the string by 38% without increasing its length, nor changing out the connecting hardware. Figure 7 shows a comparison of the existing porcelain units used on the DCPP dead end strings and the glass insulator alternative.
- Advancements in factory applied silicone coatings have improved adhesion and longevity since its development in the 1990's (Figure 5)

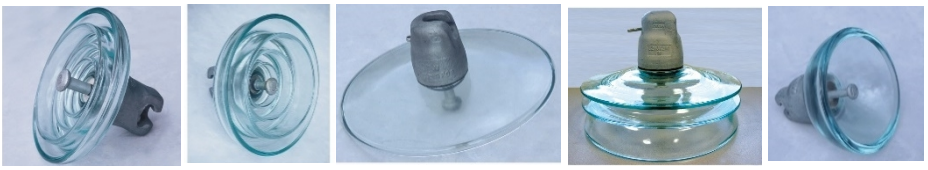

Figure 6: Different shapes for different environments

Insulator Type	M&E Rating (lbs)	Leakage Distance per Unit (in)	Insulator Spacing per Unit (in)	Number of Insulators per String	Total Leakage Distance (in)	Total Insulator Spacing (in)
Porcelain Fog Type	36,000	12.81	5.75	58	743.13	333.50
Coated Glass Fog Type	36,000	21.50	5.75	58	1,247.00	333.50

Figure 7: A comparison of leakage distance between the DCPP porcelain and the glass fog type alternative

Experimental setup & test results

- At DCPP in 2016, one of two 500kV porcelain dead-end strings was replaced by silicone coated toughened glass fog types (Figure 8)
- The insulators from both lines were observed visually, audibly, and through thermographic photos. All results showed the silicone coated glass string performed cooler and quieter than the porcelain string. The second porcelain string was soon replaced in 2017 with coated glass.
- Since the first installment of silicone coated glass in 2016, PG&E has not hot washed these insulators in the last 6 years. This is a savings of approximately 60 washes.

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Figure 8: Install of silicone coated glass insulators at Diablo Canyon 2016

Conclusion

Since the discovery of silicone coated glass insulators and their performance in polluted environments, PG&E now uses fully coated glass, and undercoated glass insulators (shown below) across their entire territory favoring this technology rather than polymer insulators which in the past were largely used by PG&E in polluted environments.

Benefits gained from this study

- Eliminates the risk of pollution flashover
- Eliminates the need to wash
- Eliminates the need for washing equipment
- Reduces risk of personal injury
- Reduces risk of equipment damage
- Reduces water waste
- Reduces the risk of generation loss
- Reduces overall maintenance cost