

Polymer vs Porcelain Suspension Insulator Equivalence - What To Use?

The superiority of polymer insulators over porcelain insulators leads to several differences in characteristics and application criteria for these two insulation systems. Examined in this article are the various criteria used in selecting insulators and the development of a suitable method for selecting the correct size polymer insulator.

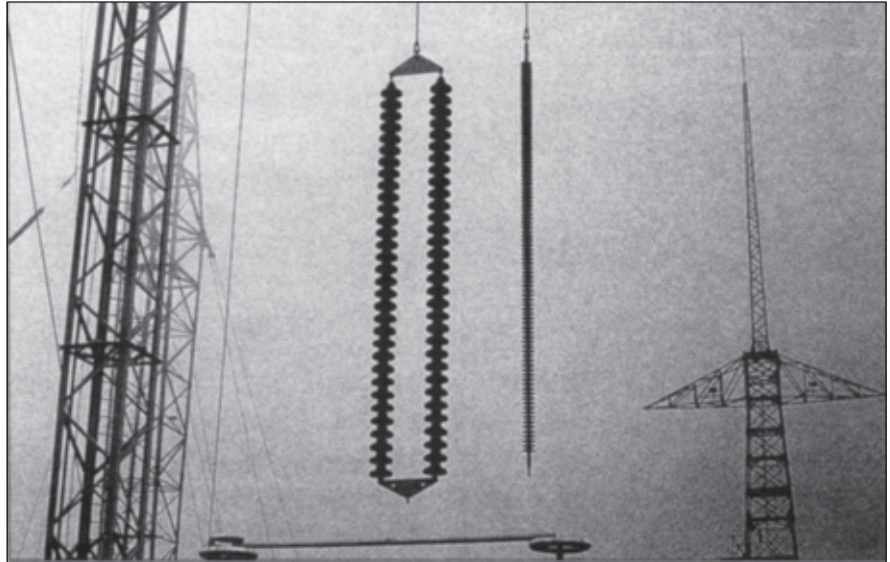
Types of Equivalence

Several different methods of making equivalence comparisons come to mind when comparing polymer and porcelain insulators. The first broad category is physical equivalences, including the strength rating of the insulators, and the section length (coupling length) of the porcelain insulator string and the polymer insulator unit.

The second broad category is electrical equivalences. Among these are the leakage distance, the 60 Hz wet and dry flashover values, and the positive and negative impulse critical values.

Physical Equivalence

The ultimate strength of porcelain suspension insulators is characterized by the porcelain mechanical and electrical (M & E) value. This value is determined from a mechanical strength test performed on individual suspension bells. The applied electrical stress tests the integrity of the relatively thin porcelain section between the cap and pin to indicate the load at which mechanical failure initiates. For



Size difference is apparent as equalled-strength insulators are side-by-side.

Ohio Brass polymer suspension insulators, the equivalent measure is the specified mechanical load (SML). The SML test is a 90-second tension withstand test at the SML value. Ohio Brass polymer insulators are available in strength ratings equal to or exceeding porcelain insulator M & E strengths.

Typically, a porcelain suspension insulator is proof tested at 50 percent of its M & E value. Ohio Brass Hi*Lite XL polymer insulators are proof tested at a value of 50 percent of the SML. This routine test load (RTL) is performed on every Ohio Brass Hi*Lite suspension insulator.

Therefore, in selecting the proper strength Hi*Lite XL insulator, consider only the porcelain M & E rating which was previously used and select a Hi*Lite XL insulator

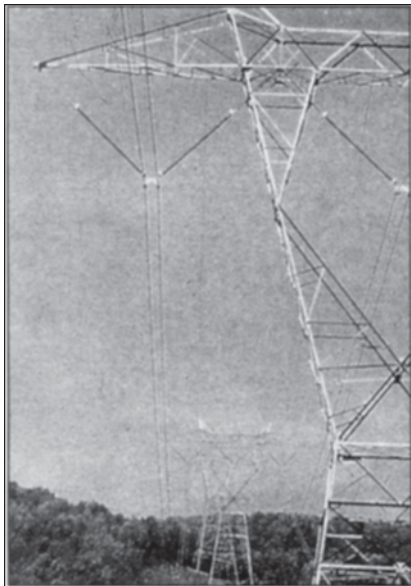
with an SML equal to or greater than this M & E value.

Section Length Equivalence

The modular construction of the Hi*Lite XL insulators can match within 1½" any section length desired. Often the structure design has progressed well before insulator selections are made, and there is little room for variations in section length. Ohio Brass Hi*Lite XL polymer insulators are produced in variable section lengths to meet any need, so the section length of porcelain previously used can be matched closely.

Electrical Equivalence

After the section length of the Hi*Lite XL polymer insulator is selected, the electrical characteristics must be verified for suitability



The low-profile, high-strength Hi*Lite insulator.

with the system voltage. In performing this analysis, three voltage stresses are typically considered: 60 Hz power frequency, switching impulse, and lightning impulse voltage.

60 Hz Power Frequency

A major cause of transmission line flashovers is contamination build-up on the insulator string. These flashovers can occur at nominal system voltage.

Leakage distance is the primary factor which determines an insulator's performance under contaminated conditions. When an Ohio Brass Hi*Lite XL polymer insulator is selected with a section length equal to the porcelain strings that were previously used, the specific leakage distance of the Hi*Lite insulator will be greater than the specific leakage distance of the porcelain insulator (leakage divided by dry arc).

For example, at 230 kV, one typical porcelain string used is 15

bells with a leakage distance of 172.5 inches. The Hi*Lite XL insulator with equivalent section length is Catalog No. 511212, which has a leakage distance of 192 inches. In this case the Hi*Lite XL insulator offers 11 percent more leakage distance in the same section length.

Switching Impulse Transient Performance

Due to improvements in breaker technology, switching transients have been greatly reduced over the past 50 years. For example, in the 1930's, switching transients were measured as high as 5.5 per unit, while today's breakers will limit the voltages to three per unit or less. Therefore, for the 230 kV system, the maximum switching surge voltage to which the insulators would be subjected is 563 kV.

$$\left(\sqrt{\frac{230 \text{ kV}}{3}} \times \sqrt{2} \times 3.0 \right).$$

The simplest way to coordinate insulation levels with expected switching surge voltages is by using the 60 Hz wet and dry values. There is some debate as to whether the 60 Hz wet or dry value should be used in the coordination. We will assume that switching will occur during a storm when the insulators are wet.

The 15 porcelain bells will have a 60 Hz wet flashover of 600 kV, while the Hi*Lite insulator, Catalog No. 511013, has a 60 Hz wet flashover of 700 kV. In both cases, the values exceed the 563 kV expected switching surge voltage.

Therefore, a Hi*Lite XL insulator chosen with section length equal to porcelain string length will have equal or better switching impulse voltage performance.

Lightning Impulse Voltages

Lightning impulse voltages are the most challenging to insulate against. Even manufacturers' literature indicates that a major design criteria of high voltage insulators is that they should not flashover under any condition except lightning.

Because lightning is such an unpredictable phenomenon, few utilities know the stroke currents for which they have designed. They only know the impulse critical positive and negative values listed for the porcelain insulator strings in use.

Often overlooked is that porcelain insulator strings frequently include one to two "insurance units". These insurance units were included in the string in the event that units were damaged during shipment or installation or punctured in service.

For example, in the 230 kV case, the 15 bells would have positive and negative impulse critical values of 1345 and 1360 kV, respectively. However, if two damaged insulators are assumed in the string, these values are reduced to 1185 and 1190 kV respectively. By contrast the Hi*Lite XL insulator is not prone to damage; it is always electrically intact. The positive and negative impulse critical voltages for the Hi*Lite insulator are 1215 and 1233 kV, respectively; in both cases they are higher.

Therefore, the lightning impulse performance of the equivalent section length Hi*Lite XL insulator will be equal to or greater than the porcelain insulator string.



Linemen prefer working with lightweight polymer insulators.

Conclusion

All of the various electrical equivalences indicate that selecting an Ohio Brass Hi*Lite XL polymer insulator with a section length equal to that previously used in porcelain insulators will result in an assembly with equivalent or superior electrical performance.

The following table summarizes the selection process. Selecting Hi*Lite XL polymer insulators equivalents based on section length is the appropriate criterion.

Table:

1. Mechanical:	Choose Hi*Lite XL specified mechanical load (SML) equal to or greater than porcelain M & E.
2. Section Length:	Choose Hi*Lite XL section length to (or greater than) porcelain section length.
3. Leakage Distance:	If step 2 is followed, Hi*Lite XL specific leakage distance will be greater than porcelain.
4. Switching Surge:	If step 2 is followed, Hi*Lite XL performance (60 Hz wet flash-over) will be greater than porcelain.
5. Impulse (Lightning):	If step 2 is followed and allowances made for "insurance units," Hi*Lite XL values are greater than porcelain.



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