SLR Document Changes: Add Polymer High Voltage Insulators

Overview of purpose of change: Add polymer high-voltage (HV) insulators to the scope and program elements of GALL-SLR AMP XI.E7. The current AMP addresses porcelain insulators, however, polymer insulators have been utilized in some nuclear plant sites and should be addressed accordingly. Polymer HV insulators include different material/environment and aging effects not previously considered in GALL-SLR and GALL-SRP.

Basis Document Input: Revise NUREG-2221 as follows.

Add the following text to Table 2-31:

The staff added polymer HV insulators to the scope and program elements of GALL-SLR AMP XI.E7. Polymer HV insulators are being used in some nuclear plant sites and are not currently discussed in GALL-SLR. Polymer HV insulators include different material/environment and aging effects not previously considered in GALL-SLR and GALL-SRP. Adding polymer insulators to this AMP enables use of this AMP to manage aging of porcelain as well as polymer HV insulators. Polymer HV insulators are typically composed of material such as fiberglass, silicone rubber (SIR), ethylene propylene rubber (EPR), epoxy, silicone gel, sealants, ductile iron, aluminum, aluminum alloys, steel, steel alloys, malleable iron, and galvanized metals. Exposure to air-outdoor can cause degradation and aging effects that can result in reduced insulation resistance due to deposits and surface contamination, reduced insulation resistance due to polymer degradation as well as loss of material caused by wind blowing on transmission conductors, all of which may require aging management. This component material/environment combination has not previously been evaluated in GALL-SLR and is considered a site-specific condition to be evaluated by the applicant.

Polymer HV insulators have been shown to have unique failure modes with little advance indications. Surface buildup of contamination can be worse for SIR (compared to porcelain insulators) due to absorption by silicone oil, especially in late stages of service life.

Typical aging degradation and mechanisms for polymer HV insulators include (but not limited to) the following:

- Deposits and buildup of surface contamination causing reduced insulation resistance, arcing and flashover
- Polymer degradation caused by thermal degradation of organic material, radiolysis and photolysis of UV sensitive material, oxidation, and moisture intrusion
- Stress corrosion cracking (SCC) of glass fibers due to sheath degradation
- Swelling of SIR layer due to chemical contamination
- Sheath wetting caused by chemicals absorbed by oil from SIR compound
- Brittle fracture of rods resulting from discharge activity, flashunder, and flashover
- Chalking and crazing of insulator surfaces resulting in contamination, arcing, and flashover
- Water penetration through the sheath followed by electrical failure
- Bonding failure at rod and sheathing interface
- Water ingress through end fittings causing flashunder, corrosion and fracture of glass fibers

Additionally, aggressive environment due to presence of and excrements from birds and rodents containing chemicals such as uric acid, phosphates, and ammonia can accelerate degradation.

References.

EPRI Report 1007752. “Polymer Insulator Survey 2002: Utility Field Experience and In-Service Failures”

Document Changes:

GALL-SLR

Revise GALL-SLR AMP XI.E7 as follows:

Add polymer HV insulators to the description and scope of the program

Add polymer HV insulators to the parameters monitored and inspected program, detection of aging effects, and acceptance criteria elements of the AMP.

Add specific polymer insulator material and aging effects to GALL-SLR Table VI

SRP-SLR

Add specific polymer insulator material and aging effects to SRP-SLR Table 3.6-1