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High Altitude Effects on Basic Insulation Levels (BIL): Choosing the Correct BIL for Your Harmonic Filter System

When calculating BIL for electric components used in mining operations, allowances need to be made for the "derating" effects caused by air conditions at higher altitudes.

Background

The mining industry is being forced into higher altitudes and harsher environments as precious metals and fuel sources become harder to locate and extract. However, ratings and specifications normally used to classify the electric equipment powering mining operations, including capacitor banks and harmonic filters, are created for systems operating at sea level – or "usual service conditions," as defined by industry standards, and thus do not take into consideration the effects of environmental variables such as altitude.

Derating

While altitude does not directly affect the performance of electric components, temperature and barometric pressure do. Combining temperature and pressure determines air density, which typically decreases as altitude increases. Because the air is thinner at higher elevations its ability to act as an insulator and a cooling agent decreases. Adjustments need to be made for this "derating" of performance when designing and costing power systems.

The underlying computations used to figure out derating levels are based on research done by Friedrich Paschen, a German physicist, who developed "Paschen's Law" in 1889.

The dividing line for making adjustments to BIL is typi-

Two 19 MVAR 5-stage metal-enclosed harmonic filter banks located at the Climax molybdenum mine in Climax Colorado, United States. This project required derating due to its extreme altitude (3462 meters, or 11,360 feet above sea level).

cally pegged at 1,000 meters above sea level. A correction coefficient is used to calibrate the adjustments to the specifications needed to make the components function correctly in thinner air. Known as the "Ka correction factor," the computations factor the derating caused by higher elevation levels to determine adjustments to "input impulse voltage" (kV), and "input withstand voltage" (kV).

Generally speaking, input impulse voltage needs to be adjusted downward 1% per 100 meters over 1,000 meters altitude and input withstand current ratings need to be adjusted downward 1% per 500 meters over 1000 meters altitude. Calculating for derating factors can seems complex, which some vendors will use to justify the sales of equipment that is larger than what is actually needed.

NEPSI has developed a calculator tool http://nepsi.com/resources/calculators/altitude-correction.htm to help engineers and engineering procurement and construction companies (EPCs) determine the correct specifications needed for gear that will perform in high altitude environments including metal-enclosed capacitor banks and harmonic filters.

Using NEPSI's calculator allows users to plug in the altitude, required impulse voltage, and the required withstand voltage – three relatively easily obtained figures. The resulting calculations show voltage class level ratings for both ANSI/IEEE and IEC standards, the two rating systems used around the world. It should be noted that calculations run through the two systems typically reveal results that are almost exactly the same.

EPCs should be aware that there are no specific standards for metal-enclosed capacitor banks and harmonic filter banks, but NEPSI uses various IEC and ANSI/IEEE standards in the design of our equipment.

EPC's should also be aware of the effects of dust on the insulating capacity of various systems and components – and for good reason. A layer of dust, air quality or other airborne contaminants will affect the performance of various components and increase BIL. This is especially pertinent in the dusty environments of mountaintop copper mining.

Electing to install a metal-enclosed capacitor bank or harmonic filter eliminates concerns about airborne dust. Enclosed systems permit insulation levels to be based on the nominal voltage rating of the equipment with appropriate application of derating formulas as provided by IEEE/ANSI and IEC standards.

Conclusion

Increasing BIL also increases costs on job sites that are already expensive and challenging. Properly sizing the equipment needed is crucial to keeping these costs in check. Designing and building a power supply and management system in areas where every square foot of flat ground comes at a price is even more critical for high altitude mines.

While crunching the numbers can appear complicated, simple tools based on accepted systems of standards and computations that have been tested for over a century can reduce the uncertainty of selecting the right-sized system for the job. NEPSI not only builds and designs our systems, we also have our own testing gear, including equipment for impulse testing.

Metal-enclosed capacitor banks and harmonic filters are more resistant to dust, bird strikes, seismic activity, and other extreme weather conditions. Because live components are totally enclosed they are also inherently safer and can be shipped to jobsites on trucks. When determining the correct size for components affected by elevation, use our tools, expertise and products to make the right decision.