High Speed Grounding System - 38kV Breaker

Introduction:

One of the critical protection mechanisms in a substation on large multi-turbine wind farms is ground fault protection. The substation transformer provides the ground source for the system so if the collector breaker opens, the wind turbine becomes isolated from the ground source. Until the turbine detects the fault, the collector cable will remain energized, driving the voltages between the cables and ground to levels well above the normal voltage magnitude. This increase in voltage can cause damage to many different components in the system, resulting costs of repairs that can exceed 50 thousand dollars.

The traditional solution has been to add a grounding transformer. Grounding transformers can have a couple of different configurations and also provide auxiliary voltages for parasitic loads. In addition, they add unnecessary equipment and construction costs. This paper will describe an alternative method to the grounding transformer, which will short all three phases of the load side of the collector breaker to ground when a collector breaker is opened in the system. This offers a lower cost alternative with the same level of protection as the grounding transformer.

Mechanical System:

The system is comprised of a collector breaker in the front of the cubicle that is a complete 38kV breaker in its standard configuration, and a grounding breaker that is a partial 38KV breaker mounted in the back of the cubicle with a high speed closing mechanism on the breaker. Using the vacuum bottles and contacts from a standard 38kV breaker to form the grounding breaker creates a very robust, fault tolerant system. The line side of the grounding breaker is connected to the load side of the collector breaker and the load terminals of the grounding breaker are shorted to ground. Figure 1 illustrates the electrical connection of the grounding system.

![Figure 1](image)
It was essential to eliminate all the time delay associated with the closing solenoid to reduce the closing speed of the circuit breaker. High speed closing is based on using the Thompson Principle where a magnetic field causes eddy currents to flow in a non-magnetic medium causing the propulsion of an object, which in this case replaces the normal solenoid plunger.

A Myers proprietary grounding controller was developed to control the opening of the collector circuit breaker with the closing of the grounding circuit breaker. The grounding system controller monitors and controls both circuit breakers to insure that upon opening of the collector circuit breaker, the system is grounded within one (1) electrical cycle with the high speed closing of the grounding circuit breaker. Each operation monitors system performance to insure repeatability and health.

The complete unit requires the same footprint as the present collector vertical section by strategically locating the closing circuit breaker in close proximity to the cable entrance area in the back of the unit. This feature is especially attractive because it allows for the capability to combine multiple functions in the same switchgear lineup.