Applying Fault Indicators to Wind Farms

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INTRODUCTION

The desire to reduce carbon emissions has led to an increased demand for alternative energy sources such as wind power. This application note explores the application of faulted circuit indicators (FCIs) to wind farm installations.

Figure 1 Wind Farm

BASIC WIND FARM CONFIGURATION

Wind turbine outputs are stepped up through a transformer and distributed underground to junction boxes. The junction box outputs are connected to a collector substation where the voltage may be stepped up again by the collector substation transformer to the utility transmission voltage.

Faulted Circuit Indicators

The loss of revenue due to a single cable fault can be substantial for a wind farm operator. As a result, it becomes necessary to determine the location of the fault as quickly as possible, isolate the faulted section, and restore the balance of the wind farm to producing electricity. SEL FCIs can help operations personnel quickly determine the fault location. As depicted in Figure 2, the terminations used for underground cables in the transformers and junction boxes are excellent locations to install FCIs.

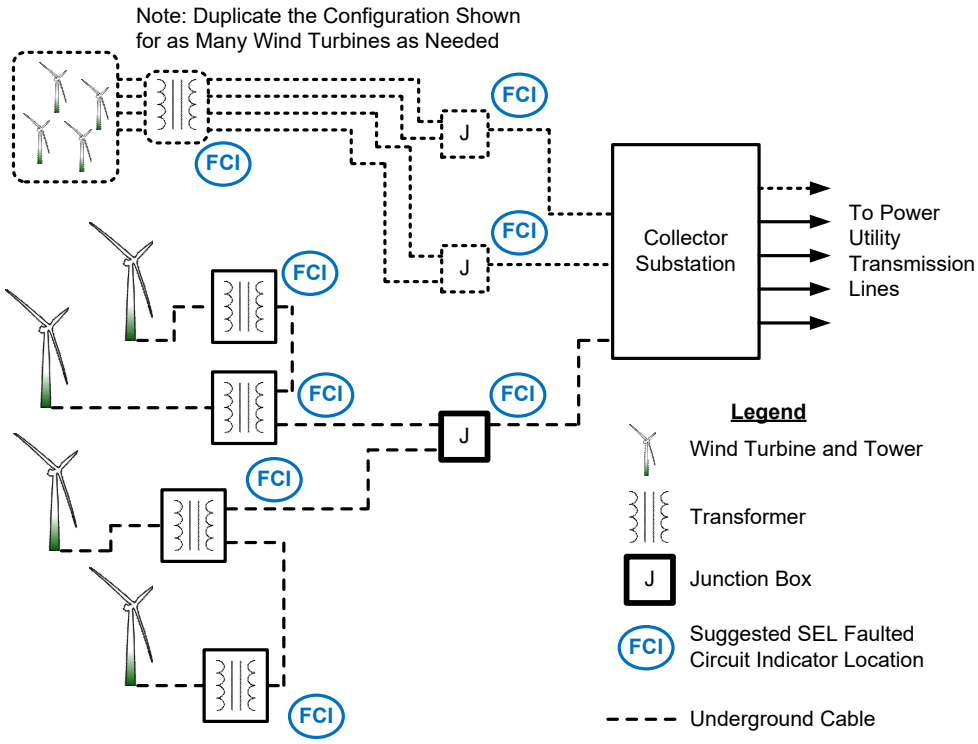

Figure 2 Typical Wind Farm Diagram

Determining the Trip Coordination of the FCI

A traditional FCI application requires coordination of the trip value with the utility substation breakers, reclosers, and fuses. An FCI trip value should be lower, and its trip response time should be faster, than all of the upstream protective devices to ensure that it activates before the fault is cleared. Wind turbines introduce another source of energy that requires coordination. During a wind farm cable fault, the power utility grid system supplies higher fault currents for a longer duration as compared to that supplied by a set of turbines on a collector string.

Directional-type fault indicators are not required for fault location if the coordination of the substation protection and the wind turbine fault contribution are understood. The SEL solution to wind farm fault locating is to select FCIs with a trip value and response time that exceed the wind turbine current contribution magnitude and duration. This method prevents the FCI from responding to fault level energy supplied by the turbines. A 1,200-ampere trip level FCI with the SEL delayed trip option allows the additional time needed for the wind turbine fault currents, which are higher than the 1,200-ampere trip level, to collapse. The only source available to trip the device is the energy being back-fed from the utility power system through the collector substation to the fault. This source provides the higher currents needed to trip the 1,200-ampere FCIs and at a longer duration than the wind turbine contribution.

This fault-locating method is similar to how fault locating is performed on typical utility distribution circuits; only the fault indicators are tripped between the breaker and fault. This nondirectional fault indication method reduces confusion during field patrol and speeds the fault location process, because the number of FCIs tripped during the fault is limited only to the ones between the breaker and fault. The SEL coordination method described above provides a simple, practical fault-locating solution for wind farm applications.

SEL FCI Wind Farm Solution

The Test Point Reset FCI (SEL part number TPR#K69N) is the suggested SEL solution for wind farm applications using terminations equipped with capacitive test points.

Figure 3 Typical Test Point Reset Installation

Test Point Reset FCI features and benefits include:

- Batteries not required; line powered means longer life and limited maintenance.
- High 1,200-ampere current trip value with delayed trip response time option to coordinate with most systems.
- Remote display so that indicator status can be quickly determined without opening the enclosures.
- Easy installation on terminators having capacitive test points.
- Integrated junction shields to ensure adjacent phase immunity in junction box applications.
- Applicable in both transformers and junction boxes to help avoid installation errors.

  Fifteen-year life design backed by a five-year warranty.

LAN2009-43

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