SIMON RICHARDS
COUNTRY : UK
REGISTRATION NUMBER : 7121

GROUP REF. : B5
PREF. SUBJECT : PS1
QUESTION N° : 1.02

Q1.02: Are risks of distance protection maloperation or failure to trip limited to transmission lines directly connected to the wind power plant or do you see broader implications for protection further away from the wind power plant point of connection to the transmission grid?

The flexibility and the choice of operating mode i.e., priority for which the Inverter Based Resource (IBR) is programmed to operate can lead to variations in fault current signature for faults fed by IBR's. Additionally, controller design parameters also have an impact on the fault current signature during the transition. The impact of the above mentioned on the phase currents during a fault is directly seen in the sequence components with negative sequence getting impacted depending upon the specific operating mode. Although standards and grid codes have recently mandated negative sequence current injection, the quantity may not be reliable during the initial few cycles, especially with Type III wind turbines. This impacts the following,

- Fault type supervision
- Quad top reactance line
- Mho characteristic

1. Issues due to frequency excursion

Frequency tracking plays a crucial role and impacts the decision of any protection element which is based on phasor information. The impacts on phasor estimation due to off-nominal frequencies are minimised by either resampling or tuning the filter coefficients based on the tracked system frequency. In conventional generation i.e., synchronous machines, the inertia of the rotating shaft restricts abrupt change in frequency during any disturbance. However, in the case of renewable generation, the frequency may vary drastically e.g., during crowbar operation in Type III wind turbines. This may result in

- zone 1 elements overreach for a Zone 2 fault or
- reverse zone operation for a forward fault depending upon the fault type.

2. Fault type supervision

Fault type identification logic supervises ground and phase distance elements and is responsible for the following important protection and control tasks, in addition to other tasks.

- Ensuring security - Blocking distance elements – Block ground distance elements for phase to phase to ground faults,
- Block phase distance elements for single phase to ground faults,
- To identify the correct fault type and to assist single-pole auto-reclosing schemes to trip the correct pole.

3. Quad top reactance line polarisation

In the presence of IBR, the use of negative sequence polarisation is not recommended, specifically when the IBR is operated in negative sequence suppression mode. Although the recent German grid code and IEEE 2800 mandate a certain amount of negative sequence injection, the angle of I2 may vary with respect to V2 for Type III wind turbines for a few cycles after fault initiation, as a result zero sequence current information shall be used to polarise the top reactance line provided zero sequence information is reliable.

4. Mho Swings

The dynamic behaviour of Mho characteristics is governed by the chosen polarising value. With positive-sequence memory voltage as polarisation, the dynamic behaviour of ground elements is a function of loop currents. Two important things can be observed: first, the expansion vector stabilises appropriately within one cycle into the fault, resulting in stable dynamic behaviour - Second: as expected, it expands towards the source (inductive) to the third and fourth quadrants.