Adaptive Loss of Field Protection

Prepared by Mutmainna Tania
Motivation/Objective

- Implement adaptive LOF relays for generator protection with wide area measurements so that these generator protection schemes can adapt with the change of system conditions.

- Prevent mis-operation of LOF relay when settings are not appropriate and avoid delayed operation.
Development of the adaptive LOF relaying scheme

Testing of the schemes through simulations of the ‘California study system’ to determine the group LOF relay settings for generators

Determine system’s current operating condition using the Wide Area Measurements (WAM)/PMU data
Methodology

Graphical Method for Steady State Stability Limit;

where, $x_t = x_{\text{trans}} + x_{\text{thev}}$

$\frac{V^2}{2\left(\frac{1}{x_s} - \frac{1}{x_t}\right)}$

$\frac{V^2}{2\left(\frac{1}{x_s} + \frac{1}{x_t}\right)}$

MW – MVAR per unit plot

R – X Plot
Methodology

Steady state stability limit circle can be adaptively fit for different operating conditions using PMU measurements.

2 concentric circles
- Inner circle is stability limit
- Outer circle is for an alarm

LOF group setting for a single generator
Case Study

Loss of Field Relay at Diablo1 (22kV), 36411
1180 MW Generator
Results

Apparent Impedances seen by Relay after LOF conditions
Loss of Field relay at Diablo1 (22 kV), 36416

Adaptive LOF settings encroached @ 1.7 s
Traditional LOF settings encroached @ 2.0 s
Results

Apparent Impedances seen by Relay after LOF conditions
Loss of Field relay at Diablo1 (22 kV), 36416

Adaptive LOF settings encroached @ 1.2 s
Traditional LOF settings encroached @ 1.9 s

Diagram: Graph showing the apparent impedances seen by the relay after LOF conditions. The graph illustrates the supervisory boundary for an alarm, Diablo to Midway (2 lines) out of service & LOF condition, Normal system & LOF condition, and the encroachment of Adaptive LOF settings and Traditional LOF settings.
Conclusion

- The traditional LOF protection might mis-operate

- The change of the system operating conditions can be identified and appropriate adaptive settings can be selected

- This improves the reliability and the operating speed of the LOF protection
References


