

SUMMARY OF A RECENT FERRORESONANCE STUDY

The ferroresonance analysis highlighted in this example focused on a new 500 kV GIS extension project for a substation that includes two new dead-tank SF₆ gas circuit breakers with a total equivalent grading capacitance of 700 pF per circuit breaker pole connected to approximately 40 m of AIS buswork and 100 m of GIS buswork. The customer was concerned about the impacts of ferroresonance conditions that may occur between the new grading capacitors of the two new circuit breakers and the voltage transformers (VTs) connected to the GIS buswork. The concern is the impact of any overvoltages on the connected equipment, including the VT secondary. Excessive overvoltages could cause damage to equipment insulation, misoperation of relays, and thermal degradation to the connected equipment.

The objectives of this study to address the concerns of the customer were as follows:

- Determine the ferroresonance conditions associated with the equipment of interest for the 500 kV GIS extension project
- Determine the impacts of the ferroresonance conditions associated with the equipment of interest for the 500 kV GIS extension project
 - Excessive overvoltages and/or current due to the ferroresonance conditions of concern here
 - Determine impacts on equipment insulation
 - Determine any potential concerns for the operation relays (misoperation)
 - Determine any potential concerns for the thermal degradation of equipment

The following table shows example conclusions for the analysis.

Example Conclusions Table

Study Objective	Conclusion drawn from simulations with ferroresonance damping device modeled ("worst-case" present-day conditions)	Conclusion drawn from simulations with ferroresonance damping device modeled (possible future scenario)	Conclusion drawn from simulations with no ferroresonance damping device modeled (for comparison purposes only) (concerns below are not realizable since damping device will be in the circuit)
Ferroresonance Conditions?	Ferroresonance suppressed with existing damping device	Ferroresonance suppressed with existing damping device	Yes, without existing ferroresonance damper
Impacts on equipment insulation?	None	None	A growing cause for concern would exist for voltages in Cases #3 and #4 with no damping device modeled
Concern for relay operation?	None (maximum residual voltage of 24.0 V rms, which is below relay set point of ~52 V rms ¹) (frequency of 60 Hz)	None (maximum residual voltage of 33.1 V rms, which is below relay set point of ~52 V rms ¹) (frequency of 60 Hz)	Yes, Case #3 with no damping device modeled has shown a low-side voltage of 111 V rms at frequency of 20 Hz
Concern for thermal degradation of equipment?	None (no excessive currents/voltages)	None (no excessive currents/voltages)	Cause for concern of winding over-heating due to excessive currents/voltages with no damping device modeled

Note 1: Relay set point is 45% of bus voltage, which is $115 * .45 = 52$ V rms.

MEPPI has performed a wide variety of detailed studies. More information on specific analysis types is available upon request.