

Assessing the Mechanical Stress on Generators in response to Rapid Change in System Frequency



SMARTer System Performance Team
Network Strategy

Test System

- Generators Studied
 - Wind generator (asynchronous machine)
 - 2 parallel machines, 1MW each
 - Inertia 3000 kgm²
 - Acceleration time constant 1.590874s
 - Terminal Voltage 6.6kV

Test System

- Generators Studied
 - Synchronous machine
 - 2 parallel machines, 1MW each
 - Inertia Time Constant 5s
 - Terminal Voltage 6.6kV

Methodology

- Linear drop in system frequency was achieved by setting up a switch event resulting in the loss of 1.5GW of generation
- Level of RoCoF was varied by scaling the Inertia Time Constants of all of the synchronous machines apart from the test machine
- Inertia Time Constant of the synchronous machine used as a test machine was kept at 5s for each case
- The following variables were measured:
 - System frequency
 - Synchronous machine electrical torque, mechanical torque and active power output
 - Asynchronous machine electrical torque, mechanical torque and active power output

Simulation Results

- Tm 1s and 2s after the switching event (as a percentage of stable Tm before the event)

RoCoF [Hz/s]	1s		2s	
	Async	Sync	Async	Sync
0.0136	100%	100%	100%	100%
0.0335	100%	100%	100%	100%
0.0783	100%	100%	101%	101%
0.1365	101%	101%	101%	101%
0.2079	101%	101%	102%	102%
0.3470	101%	101%	103%	103%
0.5377	102%	102%	104%	104%
0.7231	102%	102%	106%	105%

Conclusions

- In all examples, mechanical torque increases as a result of a drop in system frequency
- The mechanical stress on the turbine shaft created by the change in mechanical torque (both for synchronous and asynchronous generators), would not appear to be significant enough to lead to critical failure of the machine
 - More information required on what level of stress is a problem, and the related frequency of occurrence
- The mechanical stress experienced by the machines as per the Fault Ride Through requirements of the Grid Code is thought to be several times higher than that observed in this study