

ENERGY CONSULTING

# Generation Products & Services

The **Generation Products & Services** team is made up of a core group of leading technical and industry experts from GE who utilize our cross-company resources to help you solve your most difficult challenges. Our team can help ensure that your thermal or renewables power plant can meet your grid code compliance testing needs. Our team also consists of industry leading experts who can help with any power plant sub-synchronous torsional interaction analysis and risk mitigation techniques. Additionally, we have expertise in power system stabilizer (PSS) tuning, testing, and application issues, as well as specialized power plant modeling and analysis.



## Grid Code Compliance Testing

Recent power system disruptions and significant changes to the power grid, such as high renewable penetration, have prompted regulating agencies to more closely examine generating units' capabilities for dynamic support from a frequency/load and voltage/reactive power control perspective. These same realities have raised significant interest in the models of generation equipment that are used in power system planning and analysis. This has led to requirements that generating units be tested to confirm proper dynamic performance of their controls, and to update the associated dynamic model data. Testing for these purposes is now recognized as practical, having minimal intrusion on plant operations and yielding significant benefits to generating plants and to the planning of the interconnected grid.

The Grid Code Compliance Testing team executes power plant dynamic performance tests, and our team of engineers has more than 20 person-years of experience in performing tests and analysis for all segments of the power generation industry. In fact, our team has supported tests on over 3,000 generating units and renewable plants around the world, ranging in size from small diesel generating sets to large nuclear steam turbines; including both GE and non-GE power plants.

## Benefits of Grid Code Compliance Testing

Our team of experts understand the grid requirements, regardless of country or US regional variance (i.e. WECC, ERCOT, etc.). This testing provides the industry with accurate models for use in interconnected system simulation studies, as well as practical demonstration of the units' dynamic capabilities. Our efficient execution of these tests and subsequent analyses help ensure that you secure expedient interconnection approval and remain connected to the local grid. In addition, our teams are trained to help identify/uncover issues with the unit during our visit; including operational concerns, protection miscoordination, invalid equipment settings, poor response, etc.

## Sub-Synchronous Torsional Interaction Risk Analysis, Mitigation, and Testing of Turbine-Generators

Turbine-generators can be subjected to electrical environments that react with the turbine-generator shafts to produce torsional vibrations at natural frequencies. These vibrations cause cumulative fatigue damage when they exceed material fatigue limits and result in reduced component life for such parts as shafts, buckets (blades), retaining rings, and rotors. In some severe cases, these adverse interactions have led to growing oscillations and damage, including twisted couplings and broken shafts.

Since the early 1970s, GE has pioneered the analysis and mitigation of torsional problems and has offered protective relays and monitoring equipment to address these problem areas. Our current generation of torsional protection and monitoring products builds on GE's extensive experience and features digital processors, built-in monitoring, and higher reliability.

The Torsional Stress Relay (TSR) is a digital protective relay designed to continuously monitor the turbine-generator's shaft for torsional oscillations and provide trip output contacts when shaft fatigue reaches predetermined levels. Torsional event data capture is also provided. The TSR is an updated digital version of GE's proven SMF relay, which has been applied successfully since 1976 to many turbine-generators that are exposed to risks of harmful torsional interactions.



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## Benefits of GE Analysis

Our team can evaluate and recommend protection and/or mitigation solutions for those applications at risk of sub-synchronous torsional interaction. Additionally, we have the expertise in testing generator applications for sub-synchronous interaction, and support commissioning of these mitigation solutions.

## Power System Stabilizer Design, Tuning, and Testing

Excitation systems with high gain and fast response times greatly aid transient stability (synchronizing torque) but at the same time tend to reduce small signal stability (damping torque). The objective of the power system stabilizer (PSS) control is to provide a positive contribution to damping of the generator rotor angle swings, which are in a broad range of frequencies in the power system. These range from low frequency intertie modes (typically 0.1 – 1.0 Hz) to local modes (typically 1.0 – 2.0 Hz) to intra-plant modes (approximately 2.0 – 3.0 Hz).

PSS performance is often evaluated from the damping of the “local mode,” with the generator swinging against the rest of the power system. This mode is usually at frequencies between 1.0 and 3.0 Hz. Stronger system ties and lighter loading tend to give higher local mode frequencies, and weaker ties and heavier loading tend to give lower local mode frequencies. The PSS must be designed to accommodate a wide range of system conditions that can result from different operating situations, such as out-of-service lines or varying load levels.

Proper application and tuning of the PSS require a system study to identify the best practical performance. The use of small-signal frequency-domain techniques has proved to be very effective in these studies, and the Generation Products & Services team has developed simulation tools for these types of studies. Our team has performed tuning studies and supported tests on over 1,600 generating units around the world.

In addition to the damping of the low frequency modes, which are of primary importance, the PSS can also introduce undesirable effects at the characteristic modes of the turbine-generator mechanical torsional system. GE's position is that such interaction must be strictly limited for any applications involving GE turbine-generator designs. Filters to reduce torsional signal levels are found in GE's PSS designs, and the settings for the filters are determined from screening studies.

## Specialized Power Plant Modeling and Analysis

Our team of experts can go beyond the traditional power flow and transient stability models when analyzing extreme changes to the power grid. Our team of engineers has worked with leading GE gas turbine controls engineers to perform high-fidelity simulations using a unique modeling approach which combines the GE PSLF program with a detailed GE gas turbine model running site-specific controller software. These simulations can be used to determine if customer turbine design, as-running controller software, and site conditions are capable of meeting extreme grid codes, such as the new Irish Rate-of-Change-of-Frequency (ROCOF) requirements.

Based on these simulations, pre-emptive changes can be made to the existing GE EX2100e and Mark\* VIe controllers as well as provide recommended protective relay settings to ensure compliance to any new grid code requirement.

## Independent Review of NERC Model Validation Testing Reports for Renewable Resources

Our team can also support transmission planners to review the model validation test reports to comply to NERC MOD-025, 026, 027, and 032 submitted by developers of renewable projects. We can follow the methodology used by the planning team to confirm that the models submitted are usable in both PSS/e and PSLF software. Our standard approach is to create a 5 or 6 bus power flow case to represent the transmission/collector system model. The generator is set to regulate the low or high side of the station transformer (GSU), or the point of interconnection (POI) as appropriate. Voltage and frequency step tests in PSS/e or PSLF match the field tests and a fault test to confirm the model is usable.



For more information visit: [www.geenergyconsulting.com](http://www.geenergyconsulting.com)

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