Electric reliability councils/organizations all around the world develop and enforce reliability standards or grid codes to ensure the safe and reliable operation of the electric power systems. This article summarizes some of the tools (listed below) in PSS®E 33 which can be used by electric utilities and system planners for performing grid code compliance studies:

- AC contingency analysis function
- N-1-1 contingency analysis function
- Reporting functions
- Interconnection Reliability Operating Limit (IROL) checks
- Sensitivity analysis functionality
- Dynamic voltage violation checks
- Support for COMTRADE format

**AC contingency analysis function** uses a full AC network and represents advanced models such as FACTs devices, DC lines, and all kinds of automatic controls in power systems. The robust and reliable power flow solution algorithm allows users to simulate millions of contingencies within a short period of time, e.g., for a 50,000 bus system and on an Intel 2.4GHz machine, it takes about 0.1 second for solving a case. The function can simulate N-1 contingencies (Category B in NERC Transmission Planning standards), N-2 contingencies (Category C except C3) and extreme contingencies (Category D). Additionally, a contingency ranking function is provided to identify the most severe contingencies prior to performing the contingency analysis.

**N-1-1 contingency analysis function** can simulate N-2 contingency that occurs sequentially (Category C3 contingency in NERC transmission planning standards); loss of one system component, followed by some automatic or operator initiated system adjustments, followed by another loss of a system component (Figure 1). Users can choose one of three modes to handle the system adjustments: local adjustment, corrective action as well as preventive security constrained optimal power flow modes.
Figure 1 – Simulation of an N-1-1 Contingency

Reporting functions in PSS®E include text reporting, the ability of ACCC browsers to present the results in spreadsheet tables, and the ability to export results to Excel® for customized reports. Furthermore, the results can be displayed on the one-line diagrams. Figure 2 shows a contour diagram on the branch flows in a contingency solution.

The Interconnection Reliability Operation Limit (IROL) checking defines the complete procedure to assess a contingency, including actions following the contingency and mitigation strategies for the limit violations caused by the contingency (a sample is shown in Figure 3). In PSS®E, the study can be performed by the multi-level contingency analysis equipped with tripping simulation and corrective actions. Multi-level contingency analysis simulates a contingency in three phases and at each phase the operation limits are checked to ensure the IROL compliance.
Sensitivity analysis is a method to systematically study the impacts of changes in system operation conditions such as MW and MVar power injections, and phase angles of phase shifters on changes in branch flows and bus voltages. The function calculates sensitivity factors to assess the impacts, and is used for the following applications:

- Determine the loading contribution of a branch due to generation and load injections
- Provide operational strategies to mitigate the thermal or voltage limit violations
- Determine the dispatch mode of the generator to maximize power transfer from one area to another

Voltage violation checks function monitors the bus voltages for primary voltage recovery, secondary voltage recovery, and voltage dips following a fault clearing during dynamic simulation. The recovery checks are based on predefined voltage thresholds (V1, V2 and V3) as shown in Figure 4. Voltage violations, if any, are reported on the PSS®E progress window, as well as on the slider diagrams.

Support for COMTRADE format. The COMTRADE standard (IEEE Std. C37.111-1999 - IEEE Standard Common Format for Transient Data Exchange (COMTRADE) for Power Systems) facilitates exchange of the transient data for the purpose of simulation, testing, and validation. The COMTRADE file contains Phasor Measurement (PMU) and Disturbance Monitoring Equipment (DME) data. These COMTRADE files can be read into the PSS®E plot package and the recorded disturbance data can be compared with simulation results for model validation.