

PSS[®]E

Transmission Reliability Assessment

At a glance

Siemens Power Technologies International (Siemens PTI), the provider of network consulting, software solutions and T&D training in the Siemens Energy Sector, brings you comprehensive transmission reliability assessment by enhancing the core state-of-the-art analytical formulations from our PSS[®]TPLAN software and integrating them into PSS[®]E. These combined features provide program users with an all-inclusive tool to evaluate transmission reliability performance in large or small power systems on a deterministic and probabilistic basis.

The challenge

The power industry worldwide has been undergoing tremendous changes. Interest in reducing the cost of power transmission continues to grow while the reliability requirements of the system become more stringent. PSS[®]E serves as a timely tool for addressing key reliability concerns in power systems, such as:

- multiple contingency analysis (N-1-1, N-2)
- vulnerability analysis of the systems to cascading failures
- mitigation strategies to system problems
- reduction of the cost of power transmission
- development of probabilistic reliability measures

Our solution

The new transmission reliability assessment capabilities in PSS[®]E feature easy configuration, detailed modeling of remedial action schemes, effective identification of voltage collapse conditions, and automatic handling of generation dispatch and load shedding requirements.

- Multiple-level AC contingency analysis can analyze user specified and automatically selected single and multiple contingencies

within one run in addition to categorizing and storing results for easy post-processing. User specified and automatically generated contingencies can be tested individually or combined with each other as overlapping outages of up to three levels (N-3).

The contingency enumeration process is based on the use of several built-in contingency ranking schemes which provide tremendous savings in computation effort by avoiding the explicit evaluation of contingencies that are not likely to affect system reliability.

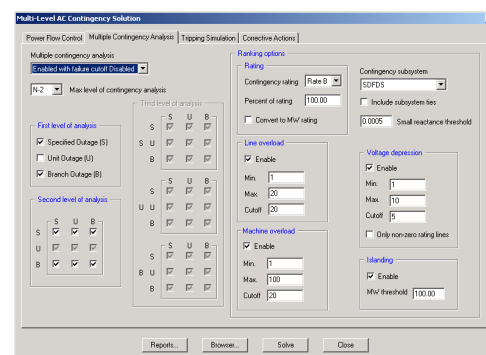


Figure 1 Multiple-level contingency analysis

- Generation dispatch allows users to simulate system response to power imbalances caused by contingencies. PSS[®]E offers four options by which generation dispatch may be performed. These provide a more realistic representation of system response instead of the traditional approach of using the system swing generator to accommodate power imbalances.

Non-divergent power flow solution provides meaningful information regarding the state of the power system during severe contingencies that will typically result in a diverged power flow solution. Using this built-in algorithm in the contingency analysis process, the user can detect the portion of the power system that is experiencing severe reactive deficiency or voltage collapse.

Siemens PTI – Software Solutions

Answers for energy.

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Tripping simulation can be designed to trip or reconnect a generator or branch, or disconnect or transfer a load in response to a specified criterion, such as a condition of low bus voltage or excessive branch flow, or the service status of a branch or machine. The tripping feature can be applied to model special protection schemes (SPS) or simulate cascading outages in severely overloaded conditions.

- Corrective action function can be applied to simulate operator actions, such as the re-dispatch of generation, curtailment of load and adjustment of phase-shifting transformers to relieve system criteria violations. This can also help translate system related reliability measures, such as the location and magnitude of branch overloads and bus voltage violations, to customer-impact indices in terms of the potential amount of service interruptions.
- Probabilistic transmission reliability incorporates the impact of frequency and average duration of equipment outages on system reliability assessment. Reliability indices are obtained relative to various system problems, including branch overloads, load interruptions, voltage-limit violations, and voltage collapse conditions. These types of indices provide a better indication of power system reliability by taking into consideration the relative likelihood of different contingencies that may occur.
- Graphical reliability result report function. Deterministic and probabilistic reliability results can be displayed in a system diagram to highlight regions that are vulnerable to reliability problems.

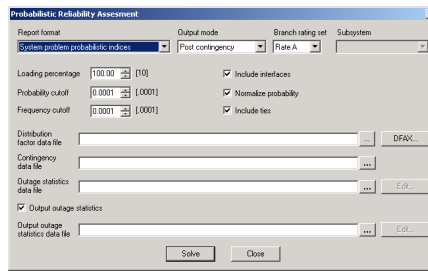


Figure 2 Probabilistic reliability analysis

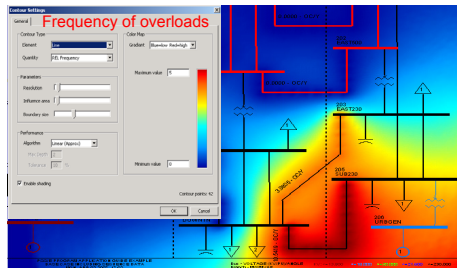


Figure 3 Contour-diagram of probabilistic reliability results

Application examples

N-2 contingency analysis

Problem: A system planner wants to know the performance of a planned system with respect to N-1 criteria, particularly the impact on voltages. The planner also wants to know the performance of the same system under extreme contingencies such as N-2 events.

Solution: The test for performance criteria such as N-1 is the subject of contingency analysis. The multiple level contingency analysis function of PSS[®]E provides a convenient means for setting up, performing and reviewing results of a contingency analysis. It allows users to define the area of concern with regards to performance, automatically selects contingencies for testing, performs AC power flow solutions, simulates network

islanding, loss of generation or load, generation re-dispatch and relay actuation schemes, identifies voltage collapse conditions and handles divergent power flow solutions. Using this tool, the planner is able to compare the effects of alternative reinforcements on the voltage performance of the system.

Probabilistic contingency analysis

Problem: A transmission company wants to find the impact of using unserved energy indices in planning its system. However, there is not much experience with this type of analysis, and there is a concern that data preparation could be onerous.

Solution: The probabilistic reliability assessment feature of PSS[®]E provides a simple process for obtaining unserved energy indices. The only data requirements are a power flow model and the outage frequency and average outage duration for each type of transmission element. The user may use typical transmission equipment outage data that are available in the literature, or actual historical outage statistics that have been recorded by the company. During the contingency analysis process, the corrective actions feature of PSS[®]E can compute the amount of load curtailment needed to eliminate system criteria violations, such as overloads and low voltages. The load interruptions are then combined with the outage statistics associated with each contingency to produce unserved energy indices which are presented to the user in table or graphics form.

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Siemens Energy, Inc.
Power Distribution, T&D Service Solutions
Siemens Power Technologies International
400 State Street
PO Box 1058
Schenectady, NY 12301-1058

www.siemens.com/energy/power-technologies

Siemens AG
Energy Sector
E D SE PTI
Freyeslebenstrasse 1
91058 Erlangen, Germany

Siemens Transmission and Distribution Ltd
PTI
Sir William Siemens House, Princess Road
Manchester, M20 2UR
United Kingdom

For more information, please contact
our Customer Support Center.
Phone: +49 180 524 70 00
Fax: +49 180 524 24 71
(Charges depending on provider)
E-mail: support.energy@siemens.com

Power Distribution Division
Printed in Germany
Printed on elementary chlorine-free
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SWPE04-EN-200905