Answers for energy.

Smart Planning with Smarter Tools

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Characteristics of Today’s Transmission Systems

Reliable on a system-basis

- Reliability may vary by location
- Prevalence of remedial measures to relieve potential cascading problems

Designed to survive severe, probable events

- Deterministic criteria, typically
- Without explicitly predicting likelihood of occurrence

Different methods for different levels

- Generation level, using probabilistic methods
- Transmission level, using deterministic methods
- Distribution level using performance-based decisions
Understanding Margins in Transmission Systems
Mapping the Challenges with the Tools

Will the loss of one element trigger the loss of other elements?

How can I identify methods relief, a violation, in a timely manner?

Will my system improvement pay back?

How do I perform breaker-to-breaker contingency analysis?

What is the best bus configuration for improved reliability?

How do I integrate all my projects into the interconnection queue?

How do I bridge the gap between operations and planning modeling?

Cascading Tripping Forecast

Automatic Corrective Action Identification

Substation Reliability Analysis

Variable Energy Resource Models

Model on Demand

Unified Transmission Model
Different Perspectives in Contingency Planning

System modeling considerations

- Load/generation imbalance
- Network separation
- Special protection systems, remedial action schemes
- Operator actions
- Cascading tripping

Customers impact considerations

- Isolation of load supplying substation from network.
- Initiation of a trip sequence, which isolates or trips loads.
- Load Curtailment

- Customer
  25 MW of load is curtailed on outage of a circuit

- System
  Line is overloaded for outage of a parallel circuit
Deterministic vs Probabilistic Approaches

**Deterministic**
- Tests system performance under different conditions (N, N-1, N-2, etc.)
- Determines contingency outcome
- Makes “Pass/Fail” decision
- 12 contingencies result in overload
- 2 of the contingencies involve line A
- Maximum overload is 12%

**Probabilistic**
- Reflects risk of equipment failures
- Multiple component failures may have more severe consequences, but are less likely to occur (have lower probabilities)
- Frequency of an overload within system is 0.2658 times/year
- Frequency of overloading line A is 0.027 times/year
- Average duration of overload is 4.6 hr
Substation Reliability Analysis

- Assess substation reliability
  - Compare substation configuration alternatives
  - Evaluate the sensitivity of substation performance to outage statistics, equipment rating, load level
- Breaker-to-breaker contingency analysis (PSS®E Version 33)
Cascading Tripping Forecast

Blackout

Tripping of one or multiple elements leads to outage of a wide area

Modeling concerns

- Network condition checked after each contingency power flow solution for possible tripping action
- If tripping action activated, power flow solution repeated and checked again for more trips

Engineering applications

- Integrated contingency analysis by specifying:
  - Tripping Label
  - Monitored element list
  - Trip element list

END
Corrective Action Analysis

Power flow solution identifies constraints:
- Branch loading violations
- Bus voltage violations
- Interface flow violations

Automatic calculation that adjusts controls to correct violations:
- Combination of controls such as generation redispatch and load curtailment
- Objective is to correct violations while minimizing control adjustments
N-1-1 Contingency Analysis

Definition

Category C.3
Defined as loss of one element, followed by system adjustments, and then the loss of another element

Solution

Requires combination of analysis
- Automatic contingency enumeration
- Automatic corrective action identification
- Cascading tripping modeling
N-1-1 Contingency Analysis

Select ith Outage

\[ i = 1 \text{ to number of contingencies} \]

Apply ith N-1 Outage

ith N-1 Base Case

Perform Corrective Action Adjustments on ith N-1 Base Case to Meet N-0 Criteria if necessary

List/Store Corrective Actions if any

Perform N-1-1 Contingency Analysis

Choose Worst Contingency

\[ \text{Performance Index} = \sum_{\text{All monitored elements}} \frac{\text{MVA Loading}^2}{\text{MVA Rating}^2} \]

# Find Worst Contingency Based on

Violations

# List/Store Violations for Each Contingency

Meets N-1-1?

Yes

No

Meets N-0 criteria?

Yes

Get Correct N-0 Base Case

No

Perform N-1 Contingency Analysis

Get Correct Base Case

Meets N-1 criteria?

Yes

No

N-0 Base Case

N-1 Base Case

ith N-1-1 Base Case

Check ith N-1-1 Case to Ensure it Meets N-0 Criteria

# Find/Apply Corrective Actions If Necessary

# Apply Corrective Action Adjustments to ith N-1 Case

# Apply Worst Contingency and Find Correction Actions

# List/Store Corrective Action

# Apply Corrective Action Adjustments to ith N-1 Base Case

# This is ith N-1-1 Base Case

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Variable Energy Resource Models

Wind Generation

- Power flow
  - Wind machine control mode used to indicate that machine is a wind machine, and the type of reactive power limits to be imposed
- Stability
  - Generic wind models with generator, electrical, and aerodynamic controls (standard PSS®E models)
  - Manufacturer specific wind models (user-written models)

Solar

- Photo Voltaic Stability Model (PSS®E Version 33)
Beyond One Base Year, One Base Case

- Improves model quality and ensures data consistency among users
- Manage model data inputs from multiple sources
- Manage generation interconnection queues and associated model needs
- Allows access to models and model data from remote sources
- Built-in file submittal review process
- Remote user access via the web
Unified Transmission Model

Description

 Seamlessly Integrated PSS® products help customers to harmonize operation and planning, from the past, present to the future.

Customer Benefits

Understand the Past with PSS®ODMS + PI Historian
- Re-enact the sequence of events in the network
- Investigate how to avoid future contingencies

Manage the Present with PSS®ODMS + EMS/SCADA
- Improve reliability though CIM/XML format real-time data from multiple EMS/SCADA systems

Secure the Future with PSS®E + MOD®
- Model, preview and verify planned network changes in advance of commissioning
- Identify the system reliability limits and plan for reinforcements

Case Study of PowerLink, Australia
Thank you!

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