5.1.2 SE Solution Quality and Availability, including Links

5.1.2.1 SE Communication & Data Links

The Network Topology Processor and State Estimator are dependent upon timely receipt of data from generating companies, as well as, transmission owners to provide status and analog information. This data is provided via ICCP-links for transmission and owners of large generating plants. For some small generating companies, SCADA data is used as input.

A link outage report is maintained for all PJM links. When a link is down, the incoming data is obviously bad so it is important to keep the links functioning and providing good quality data. In addition, the TOAC Metrics report records performance statistics representing Transmission Owner performance on EMS, State Estimator Convergence and data (into their system and into PJM system). ICCP links, as well as, links to generating plants are monitored by the PJM EMS. Alarms are generated whenever abnormal conditions occur. Operators and our Reliability Engineering staff are trained to handle some problems directly. If they cannot, during normal business hours back-office staff will be called upon to assist. If off-hours problems occur then PJM has an on-call list to provide support. If the problems are determined to be on the TO or GO end, contact lists have been established to help resolve the problem as quickly as possible.

5.1.2.2 SE Solution Quality & Availability

The PJM SE is triggered to execute every minute. PJM maintains a record of State Estimator convergence in spreadsheet form to measure availability. It is calculated monthly as number of converged solutions divided by the total number of attempted executions of the program (converged + non-converged solutions). The SE Convergence percentage is an overall picture of how robust the solution algorithm and model is but the number should be used carefully. Historical convergence statistics illustrate that the model is very well-conditioned, solving in well over 989.7% of the attempted executions. With the PJM SE triggered to execute once per minute this translates to 4 or 5 non-convergent solutions per day.

Any non-convergence problems are reported through the EMS alarm package, immediately investigated and resolved as quickly as possible. Operators and on-shift Reliability Engineers are trained as the first line of defense with back-office and call-in staff available for higher level support. Historically, SE divergence is most likely to be caused by problems with the ICCP link data wherein data for entire companies is not available, creating significant data skews and/or erroneous status points, etc.

EMS support staff members routinely:

- Review anomaly tables
- Review residual tables
- Analyze performance indicators such as the number of iterations to converge to a solution and to assess if poor metering or poor modeling is evident
- Investigate all problems reported by operators and reliability engineers.

In the effort to ensure model quality and dependable accurate solutions, prior to placing a new model into production, EMS support staff members complete a rigorous ‘soak’ test. The testing interfaces SCADA data directly to the new model to ensure that the models produce a stable solution consistent with the results of the previous model.
In addition, upon request PJM staff will exchange results of the PJM SE with representatives of the various TOs to compare PJM and TO SE results and provide a dump of the SE model in PSSe format for the TO’s to review.

Results from the PJM SE may be compared to the SE results produced by the TO and/or other company. If there are differences which cannot be readily explained, PJM support staff members will work with TO representatives to compare results and models until all the differences can be explained. Depending upon the results of the investigation, appropriate actions are taken.

During normal business hours, support staff members are available. Members of the PJM EMS support staff coordinate their availability to provide call-in support during off-normal business hours. Restoring SE is afforded immediate priority.

5.1.2.3 Validation & Benchmarking New EMS Models

Prior to placing a new model into the production system, PJM staff members complete a rigorous ‘soak’ test. The new EMS model is implemented on a Test system and a complete set of the SCADA data linked to the current real-time model is interfaced to that model. The soak test spans a three (3) to four (4) week period, designed to ensure that the model will produce stable, accurate solutions over a wide array of operating conditions. Results from the test system are compared to results from the production model to determine if they are consistent. As inconsistencies or model errors associated with either State Estimator or Contingency Analysis (see Section 5.1.4) results are uncovered, adjustments and corrections are made to the new model.

For a two (2) day period prior to the scheduled transfer of the new model to the production system, PJM closely monitors the SE solution on the test system. The test model is ready for transfer to the production system if:

- 98% of SE solutions converge
- No more than 10 consecutive non-converged solutions
- Average number of solution iterations is <20
- Number of bad data points is <25 (<.05% of ~ 51,000 kV, mW, mVAR & Tap analogs)
- Pre- and post-build SE Bad Data differs by no more than 2 existing locations
- Worst anomaly in PJM footprint <50% of reading