Attachment H: Power System Modeling Data

Power System Modeling Data

Accurate power system modeling data is a key component of quality power system analysis. PJM System Planning uses a variety of models and analytical techniques to create and maintain the models used for the RTEP. The intended use of this Attachment is to supplement existing documentation by PJM and other entities that govern modeling data quality requirements. PJM will continue to follow the data quality guidelines and standards set forth by NERC as part of the MOD standards and the Multiregional Modeling Working Group (MMWG) Procedural Manual.

Load Flow Analysis Models

Basecase creation is a collaborative process between PJM and its members. From a technical standpoint PJM follows the regulations set forth in the MMWG Procedural Manual. In the following sections, the logistics and transfer of information between PJM and its members are detailed.

Annual Updates

Annually, no later than December 1st, PJM will request from each Transmission Owner:

- A Current year + 5 summer peak network model, based on the most up to date MMWG case combined with the previous year's RTEP case containing all upgrades identified during that RTEP cycle, that includes
  - Network model updates to the current year + 5 base case to update the case that will advance the case to be a current year + 5 base case with respect to the 1st Quarter of the following year
  - Complete NERC category B and C contingency file updates that correspond to the updated network model
  - Any other significant changes such as new load or block load additions

Additionally, PJM will request from each TO:

- TO's may be asked to support the development of network models for additional years and demand levels in the near term (years 1 through 5) and longer term (beyond 5 years) that are in the analysis scope for that particular RTEP cycle.
- Complete NERC category B and C contingency file updates that correspond to the updated network model
- Any other significant changes such as new load or block load additions
- Maximum credible disturbance (NERC Category D) contingencies

PJM requires that Transmission Owners provide within 4 weeks of receiving the initial draft network model:

- Updates to the case and contingency files that have been reviewed for correctness and compatibility with the final version of the basecase under development
- Behind the Meter information

- Specific information regarding generator capability per MOD 10 and MOD 12
- Verification that all baseline, network and supplemental upgrades are included in the updated case along with a written description of any case modifications.
- Notification of any changes to tie lines whether they are ties internal to PJM or to external companies.

Load Flow Modeling Requirements

In addition to the guidelines set forth by NERC and the MMWG procedural manual, PJM uses several specific procedures in setting up the base case so that it is the best starting point for the annual RTEP analysis.

Interchange

The PJM net interchange of is determined by the firm interchanges that are represented in the PJM OASIS system.

Generator Reactive Capability

Annually, PJM models the generator reactive capability (GCAP) of each PJM generator based on data coordinated with PJM operations. These reactive capability limits are calculated using information provided by the Generator Owners. Planning studies use the default limits obtained from the d-curves.

Interconnection Projects With Interconnection Service Agreements (ISAs)

PJM adds queue projects with signed ISA into the base case as well as verifying the accuracy of queue projects that have not yet signed their ISA. PJM also includes the interconnection, ratings and associated upgrades in the base case. Transmission Owners will verify the accuracy of these projects and their associated upgrades in their zones.

Real and Reactive Load

Each TO is responsible to model the real and reactive load profile in their zone. PJM will scale the load in the base case to the targeted values reported in the latest annual PJM load forecast report. Real loads will be scaled uniformly in each zone to meet the PJM load forecast minus any Demand Response (DR), Energy Efficiency (EE), or Behind the Meter generation as necessary. Reactive load in each area will be scaled at a constant power factor along with the real load for peak load analysis. For light load analysis PJM will provide a case for which each TO is responsible for updating the load profile for reactive load at their own discretion.

Voltage Schedules

The setting of voltage schedules is crucial to the robustness of cases. PJM allows Transmission Owners to supply generator voltage schedule data. If the data is not provided in accordance to the MMWG procedure manual, PJM will use the default voltage schedules as defined in PJM Manual 03.

Submittal of Load Flow Data

Acceptable Data Formats

- For PSS/E users, cases should be submitted to PJM in a ".SAV" format in a PSS/E version that is readable by the current version of PSS/E that MMWG is using.
- For users of PSLF or other modeling software, cases shall be submitted to PJM in a ".RAW" format that is PSS/E compatible and is readable by the current version of PSS/E that PJM is using.

Timing

Transmission Owners must comply with the schedule dictating the timeliness of the case creation process which will be included in the initial email sent to kick off the process. This schedule will include a minimum of 4weeks to provide updates to the case and corresponding files for the first iteration, and 2 weeks for the second iteration.

Load Flow Data Quality

Transmission owners must provide data that has been shown to pass all of the testing included in the MMWG data checker. In addition to the requirements of the MMWG data checker, Transmission Owners must also provide unique bus names or circuit ID's for each winding of all transformers. Bus numbers must also be within the allocated bus number range for each company.

Modeling and naming of machines must also follow the convention used by PJM including Machines ID's which should not be named "H" or "L" except for the high/low pressure units which should be modeled on the same bus. Additionally multiple machines modeled on the same bus must have the same status, so offline machines should not be modeled on the same bus as machines which are online. Machines at the same plant with different statuses should be modeled on separate busses connected by a zero impedance line.

Short Circuit Data

Short Circuit data procedures are documented in the Attachment G.7 if this manual, which references ANSI/IEEE 551. In addition to the procedures in Attachment G.7, this attachment outlines the data requirements which PJM follows in creating the short circuit cases used for analysis.

- PJM will request new TO short circuit models at approximately 2 year intervals.
- Short circuit models should be provided in Aspen ".olr" format, if possible.
    - At the time of this writing, CAPE and PSSE users can't accommodate this requirement.
- All the TO provided Aspen ".OLR" cases should have only their own TO area modeled as well as their tie lines. No outside areas should be included in the submission.
- All area numbers in the TO provided cases should be consistent with MMWG designated area numbers. Area numbers such as 1, 2, 3, etc. are not acceptable.

- All TO provided Aspen ".OLR" cases should have all TO circuit breakers rated above 100 kV modeled in the case.
- Generation owners must submit to PJM all their breaker data for breakers rated above 100 kV.
- TOs must submit an excel sheet containing explanations for outaged equipment that is normally in-service
- TOs must submit an excel sheet containing explanations for out-of-service breakers that are normally in-service

Stability Data

The base case used for stability and dynamic studies is developed by PJM based on information from the Regional Transmission Expansion Plan (RTEP) case prepared by PJM Interconnection and the NERC case prepared by Powertech Labs for the Eastern Interconnection Reliability Assessment Group (ERAG) and the System Dynamics Database Working Group (SDDWG).

When preparing the base case for stability and dynamics, the NERC case provides the information for the areas outside PJM while the RTEP case provides the PJM information (e.g. load forecast, network configuration). When combining the NERC and the RTEP cases, care should be taken to preserve the ties between the PJM areas and the rest of the Eastern Interconnection.

All of the queue projects active in PJM queue process that have been studied must be included in the base case for stability and dynamics. In some instances, the RTEP model for the queue project may not be detailed enough for use in stability studies. In this situation, the case must be updated to make sure that all detailed components are included in the stability and dynamics power flow model (e.g. generator step-up transformer, loads).

In addition to updating the power flow case with the latest network information, the dynamic models must also be updated to reflect the changes introduced by the RTEP case and the stability and dynamic studies performed by PJM. In this regard, the NERC dynamic data file from the SDDWG case is updated so that the dynamic models for the machines in the PJM areas are matched against the new powerflow information from the RTEP. The dynamic model for each queue project must also be added to the NERC dynamic data file.

The resulting powerflow case, the dynamic data file and supporting files required for a complete stability and dynamics base case need also to be correlated and reviewed to determine inconsistencies as well as missing or questionable data. A base case is considered to be finished when, after the review, it compiles, links the models to the PSS/E main structure and initializes correctly. An acceptable base case must also show no deviations from the initial conditions for any simulation setup with no disturbances applied to the system.

Stability and dynamics base cases:

Stability is assessed using a summer peak load and a light load condition. The summer peak stability case has the load profile of the RTEP summer peak case and corresponds to the demand expected to be served in the specific planning year. The light load stability case represents 50% of the summer peak load and is developed by scaling down the summer peak load case at the same power factor. For simplicity, it is recommended to first build the summer peak case and then update that case to reflect the second load condition (light load). This approach provides two cases that are common in bus numbers and network information. Updates to both cases, such as addition or removal of proposed lines or queue projects would be easy to handle due to the uniformity.

After the powerflow case has been finalized and revised, the dynamic data file from the NERC will be updated to reflect the changes that were introduced by the addition of the PJM areas from the RTEP case and generation interconnection studies. It is important to note that the RTEP case and the NERC case compliment each other. For future queue projects and transmission upgrades which don't exist in the NERC case, we use RTEP case information. For the existing units, we use NERC case information.

After the summer peak case has been finished, the PJM load is scaled down to a load representing 50% of the 50/50 load. The areas outside PJM are updated with the light load case from the corresponding NERC case. Note that generation and shunt capacitors may be turned off or disabled in order to achieve convergence of the power flow. In addition, all pumped storage hydro units are modeled in the pumping mode with their governors and power systems stabilizers deactivated or adjusted to reflect the appropriate operating condition.

TO Responsibilities:

- Provide necessary supporting data for stability case build upon PJM's request
- Provide load representation data (CONL file) if the load representation is different from the one in the SDDWG series
- Verify upgrades and generator modeling (MVAbase & Topology) for existing units

It is important to note that if there is any discrepancy between the RTEP case and the SDDWG case for existing units, we always follow the SDDWG cases.

A complete base case (summer peak or light load) must include at least:

- A powerflow file: This file contains the network information and provides the initial conditions for the dynamic models.
- A dynamic data file: This file contains all the information necessary to simulate the dynamic response of the various system components.
- A gnet file: This file contains the information of those generators that do not have a dynamic model. Any generator listed in this file is considered as a negative MVA load.
- A conl file: This file indicates how loads will be modeled based on a combination of constant MVA, constant current and constant admittance. It is strongly

recommended that each TO develop more accurate load representation for stability and dynamics studies

Dynamics Data Submittal Requirements and Guidelines:

The Multiregional Modeling Working Group (MMWG) provides the following topics pertaining to dynamics data submittal requirements and guidelines. This information is accessible in Appendix II of the MMWG Procedure Manual V5. A hyperlink to the manual is located at the bottom of this section.

- Power Flow Modeling Requirements
  - Bus name identifiers for synchronous condensers, Static VAr Compensators (SVCs) modeled as generators, switched shunts, relays, and HVDC terminals.
  - Step-up transformer representation requirements for both MMWG power flow cases and non-MMWG power flow cases.
  - Resistance and reactance data placements for step-up transformers represented in the power flow generator data records.
  - Xsource value representations in the power flow generator data record.
  - SVC representation requirements in power flows.
- Dynamic Modeling Requirements
  - Synchronous generator and condenser modeling / associated data requirements and exceptions.
  - Additional representation requirements and exceptions for synchronous generators and condensers modeled as described in Requirement II.1.
  - PSS/E modeling requirements for any other types of generating units and dynamic devices.
  - Exceptions to the use of standard PSS/E dynamic models.
  - Required written documentation and its submittal procedures for user-defined modeling in MMWG cases.
  - Generating unit, synchronous condenser, and other dynamic device requirements for netting.
  - Lumping conditions of similar or identical generating units at a plant.
  - Location requirements for per unit data.
  - Exception procedure for any requirements listed.
- Dynamics Data Validation Requirements
  - Dynamics data screening requirements
  - Preliminary procedures to undergo before regional data submittal to the MMWG coordinator.

- Material required by each region to test the validity and stability of the dynamics model.

- Guidelines
  - Additional documentation that should be submitted with dynamics data.
  - Information pertaining to parameters for representing loads via the PTI PSS/E CONL activity that the regions should provide to the MMWG.

MMWG Procedure Manual:

V5https://rfirst.org/reliability/easterninterconnectionreliabilityassessmentgroup/mmwg/Documents/