GO Perspective on Frequency Response Resources

NERC FR Conferences

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NERC Mandated Data Communication

What - Generator Capability (MW and MVARs), Transformer Data, Generator Dynamic Data, Speed Governor Characteristics, Aux System Load Requirements

When – Annual Updates, but Significant Capability Changes Requires Immediate Reporting such that operating models can be revised

Transmission Department Processes that depend on system model Information, such as normal operations, planning, etc

Transmission System Model Data

Generation Plant Data

Generation Department process that impact system model Information, such as plant changes, operating limitations, validation tests, new plants, etc

Complications

- NERC historically a Transmission focus except for Markets. GO/GOP began to focus after 2007.
- Many different industry structures (vertically integrated vs. IPP/TO) - who is really responsible for what?
- In market based structure, cost cutting, no incentive to maintain equipment expertise - Plants get paid for MWhs. Will follow mandatory NERC standards but maintaining expertise current with evolving issues not considered economic.
- Grids not designed to common “standards”.
- Communication between TO and GOP is hampered by oversensitivity to code of conduct and standards repercussions, especially where an IPP may compete with native generation.
  - This should not be an issue with Frequency Response but...

Recent Trends

- Plant engineering, design, construction and modification outsourcing - less involvement of engineers with understanding of grid issues – not many available.
  - Engineering companies use young (less expensive resources). Minimal graduates in Power Systems. Issues not typically covered in industry initiatives, such as EPRI plant training.
  - No link of recent grid standards with plant design standards (i.e. IEEE, EPRI URD).
  - Controls engineers do not understand “Response Obligations”
- New NERC Focus groups – EPRI and NAGF – no “grid” INPO
- Standard new plants w/o considering local design needs – interconnection studies must identify issues prior to approval.
  - Recent NAGF question – what standard plant features are needed?

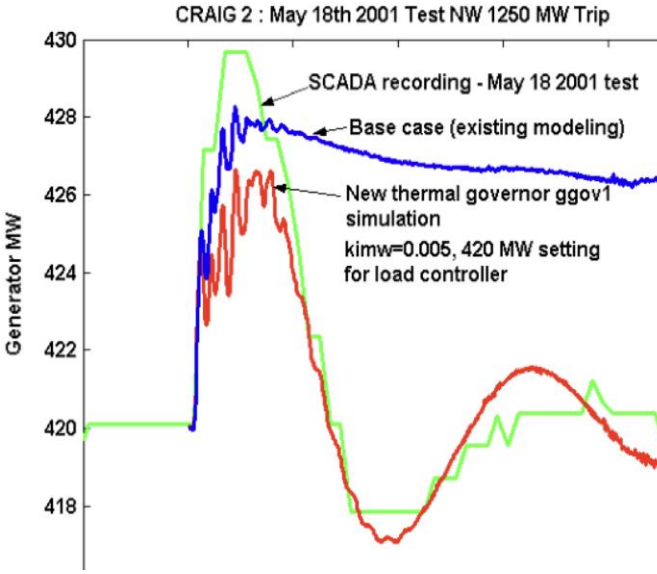
Long Term Legacy (Prior to Mandatory Standards)

- Different MW power sources lead to different technical issues

- Good engineering (ME) ≠ Good engineering (EE). Full operating MW capability of old coal plants may be > designed MW (Prated) in assumed in models.
  - Over time, replacement of worn out turbines with new, more efficient components , tuning steam cycle operating efficiencies based on new knowledge
  - May operate well above original rated MW power levels and thus may be “FR Limited” due to actually operating continuously at the Pmax and Valves wide open (VWO).
  - Boiler output not changed thus, were not considered planned uprates.

Frequency Response and Governors

- Generator MW output responsiveness to Frequency changes
- Early models assumed all units can be modeled as responsive using droop and deadband – invalid assumptions continue which has caused us to miss the big picture - how a unit MW output can be expected to change with frequency.
- Individual Response obligations not well understood
  - Desired response is 1% for 2 minutes?
- Digital governor Max Power Limits
- Plant control system over-rides gov response
- Terminology is key. Ask a GO/GOP
  - How will unit respond to Freq.?
  - Not What is your governor droop and deadband?



Problem – Understanding generator frequency response

- Differences in terminology used by plant vs. model engineers (typically software based), e.g.
  - SERC Regional Criteria – Most utilities employ Power Technologies Inc. (PTI) Power System Simulator for Engineering (PSS/E). Consequently, the various activities in the procedural manual incorporate PTI's procedures and nomenclature in describing these activities. **GO's do not speak this language.**
- Models didn't consider VWO, max power limits, etc.
- Lack of clear definitions and use of different terminology for modeled generation assumptions and terms creates confusion on what is needed
  - New NERC Standards and Glossary do not align

Inconsistent standards terms

- NERC Glossary Term Normal and Emergency Rating, however
  - MOD-024 MW - Verification of Generator Gross and Net Real Power Capability
    - Now moved to MOD-25 after industry comments that this is not needed – more confusion
  - MOD-027 - To verify that the turbine/governor and load control and active power/frequency control model and the model parameters, used in dynamic simulations that assess Bulk Electric System (BES) reliability, that accurately represent generator unit real power response to system frequency variations.
- Need consistent terminology understood by both sides

P-max – Is this "Emergency" Rating?

- **Pmax** – The maximum MW output that is expected to be available in a system emergency and be produced by governor response to frequency dips.
- Plant control system should allow for automatic frequency response if possible. If appropriate, Pmax might = Gross Continuous Capability (GCC – MOD-024 - e.g. the unit has no frequency response capability).
  - Hydro units can accept short periods of cavitations without significant shortening of turbine blade life
    - may be able to provide
    - control system design needs to support – define what is needed?
  - Units with Valves Wide Open could respond if operated below Pmax, but would need to continuously sacrifice MWs to have that ability - what is the incentive/cost for them to do so?
  - Gas plants could use emergency limits, but operation would exceed operating temp limits, shortening time frames to significant rebuild costs – what is the incentive for them to do so?
  - Nuclear units could respond above 100%, but likely would have to change plant licensing basis to do so – what is the incentive for them to do so.

Staged Governor Parameter Testing

- Conditions during Load Rejection ≠ Conditions during full power operation. Thus, staged testing does not accomplish goal yet discussion still exists to require it. Plants consider this a risky evolution.

- Can validate against ambient data from system response (large loss of generation, a system fault, etc), however, this requires a recorder preinstalled to collect generator MW and frequency during an event, e.g. digital fault recorder (DFR).

- EPRI PPPD Software or equivalent (MatLAB) may perform "parameters tuning" to include load control models.

Suggested Initiatives

- Must transition from Knowledge based to Process based Configuration Control Guidelines
  - What should be considered when plant changes might affect models
  - Revise FAC-8 Documentation
  - Integrated change-based revalidations would best assure models and help develop/maintain needed technical expertise.
    - Unit up-rate activities or generator rewinds
    - MOD-26 validations where appropriate
    - Inertia Changes due to Turbine, Generator Rotor or Exciter replacements
    - Include Frequency Response considerations in plant control changes

Suggested Initiatives

- Consensus MW power terms in Glossary, such as
  - Normal (GCC) vs. Pmax Rating
  - Desired Response (obligations) – 1% for 2 minutes?
  - Pmax that respects plant limitations - NRC imposed limits, Thermal Limits (CTs), Operating Valves Wide Open
  - Ramp Rates – how fast can a unit transition from Normal to Emergency Rating if governor response calls for increases.
- Need to be clearly understood and supported by plant design if plant frequency response will be optimized
- NATF initiative for model guidelines with standard definitions.
- GO/GOP Training on System Issues
  - EPRI & NATF collaborate to develop?

Research “Smart” Tools - UNCC ARPA-E Application

- Develop Optimized Platform for System Analyses, Model Configuration Control and Validations to Support Bulk Electric System (BES) Reliability”
  - Consistent definitions, research Generation Aux system load models and transient ride through (PRC-024)
  - On line model tool that can monitor system response though DFR data and alarm when models don’t match. (PPPD model validation on steroids) - AVR/Exciters, Speed Governor, Load Models and Transformers?
  - Integrated analysis tool that can be used to perform all analyses (LF, TS, SC, Real Time, etc) to minimize and simplify database management.
  - Study system and unit/plant controls (Power load Unbalance, MW setpoints, area control actions, generation control loops) within and beyond the transient stability timeframes between 15-25 seconds.
  - Research will be integrated into the UNCC EPIC Engineering curriculum to **train the next generation power system workforce**.
  - Contact Dr Salami @ UNCC EPIC Center if interested in learning more about concept

QUESTIONS?