Agenda Item 4.b.i
OC Meeting
December 10-11, 2013

Eastern Interconnection Frequency Initiative Whitepaper

Date: October 28, 2013

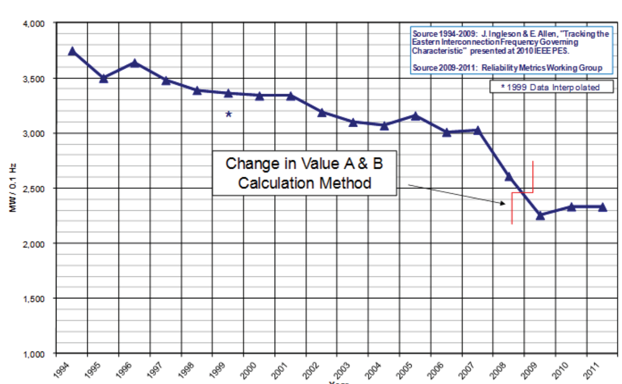
Prepared by Members of the NERC Resource Subcommittee

Preface:

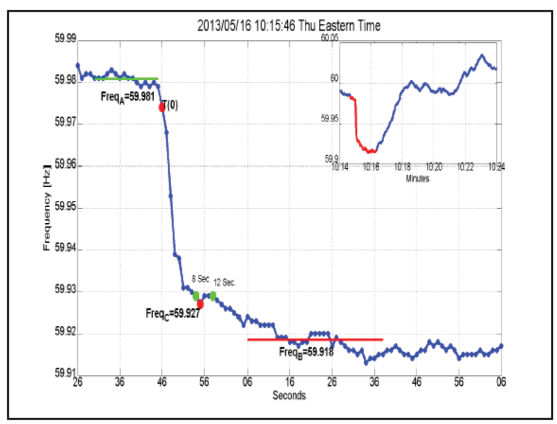
Members of the NERC Resource Subcommittee, who are representatives of the Eastern Interconnection, are working with Balancing Authorities within the same interconnection on a voluntary basis to support a pilot program in an effort to improve frequency response. Frequency Response is defined as automatic and sustained change in the power consumption or output of a device such as generator that occurs within 5-20 seconds of and is in a direction to oppose a change in the Interconnection Frequency. While it has been determined that the Eastern Interconnection has generally sufficient frequency response as a whole, there are clues that point to issues with generator governor settings. The sponsors of this initiative believe that proper and consistent governor settings are the low hanging fruit to allay concerns raised by the Federal Energy Regulatory Commission (FERC) as to past trends in frequency response and the differing appearance of frequency in the East, compared to other Interconnections.

Prior to 2010, frequency response has been declining in the East when it should have been increasing with increasing customer demand and the addition of complimenting generation. Additionally, post-event frequency typically exhibits a "lazy L" shape likely caused by set point control overriding the initial response provided by governors.

Figure 9: Updated Eastern Interconnection Mean Primary Frequency Response (May 2012)



Source "Frequency Response Initiative Report", October 30, 2012



Example of "lazy L" a common frequency response characteristic of Eastern Interconnection

Source "CERTS NERC Interconnection Frequency Events May 2013 ", October 30, 2012

The initiative focus is on the existing generator fleet with respect to 1) the completeness and accuracy of the data provided in the 2010 NERC Generator Survey 2) improving their frequency response capabilities, and 3) for Balancing Authorities and/ or Reliability Coordinators to install tool(s) to monitor individual generator performance within their authority of control and communicate performance results to the individual generators.

Introduction:

Frequency Response has been the focus of increased attention, analysis, development of standards, and deliberation by stakeholders. The foundation of this complex issue is the performance of governors. The starting point to address the issue is to have a firm understanding of current governor settings. The Resources Subcommittee believes the logical place to begin is to confirm generator data, make changes to settings where feasible and to share tools that can measure governor response.

Frequency Control

To understand the role Frequency Response plays in system reliability, it is important to understand the different components of frequency control and the individual components of Primary Frequency Control, also known as Frequency Response. It is also important to understand how those individual components relate to each other.

Frequency control can be divided into four overlapping windows of time:

> **Primary Frequency Control (Frequency Response)** – Actions provided by the Interconnection to arrest and stabilize frequency in response to frequency deviations. Primary Control comes from automatic generator governor response, load response (typically from motors), and other devices that provide an immediate response based on local (device-level) control systems.
>
> **Secondary Frequency Control** – Actions provided by an individual Balancing Authority or its Reserve Sharing Group to correct the resource – load unbalance that created the original frequency deviation, which will restore both Scheduled Frequency and Primary Frequency Response. Secondary Control comes from either manual or automated dispatch from a centralized control system.
>
> **Tertiary Frequency Control** – Actions provided by Balancing Authorities on a balanced basis that are coordinated so there is a net zero effect on Area Control Error (ACE). Examples of Tertiary Control include dispatching generation to serve native load; economic dispatch; dispatching generation to affect Interchange; and re-dispatching generation. Tertiary Control actions are intended to replace Secondary Control Response by reconfiguring reserves.

Time Control – This includes small offsets to scheduled frequency to keep long term average frequency at 60 Hz.

Primary Frequency Control – Frequency Response

Primary Frequency Control, also known generally as Frequency Response, is the first stage of overall frequency control and is the response of resources and load to arrest that locally sensed changes in frequency. Primary Frequency Response is automatic, is not driven by any centralized system, and begins within seconds after the frequency changes rather than minutes. Different resources, loads, and systems provide Primary Frequency Response with different response times, based on current system conditions such as total resource/load mix and characteristics.

The NERC Glossary of Terms defines Frequency Response in two parts as:

- **(Equipment)** The ability of a system or elements of the system to react or respond to a change in system frequency.
- **(System)** The sum of the change in demand, plus the change in generation, divided by the change in frequency, expressed in megawatts per 0.1 Hertz (MW/0.1 Hz).

As noted above, Frequency Response is the characteristic of load and generation within Balancing Authorities and Interconnections that reacts or responds with changes in power to variations in the load-resource balance that appear as changes to system frequency. Because the loss of a large generator is much more likely than a sudden loss of an equivalent amount of load, Frequency Response is typically discussed in the context of a loss of generation.

2010 NERC Generator Survey

Of those that responded to the 2010 NERC Generator survey data in the Eastern Interconnection, only approximately 57% (Figure 1) provided a generator dead band setting. The remaining 43% provided no responses or responses that did not provide the governor settings (e.g. "Looking into" or "Researching this"). Additionally of those that did respond with a dead band value, the majority of those responses reported values close to or equal to zero or exceeded the historical NERC Policy 1 value of 36 mHz. (Figure 2)

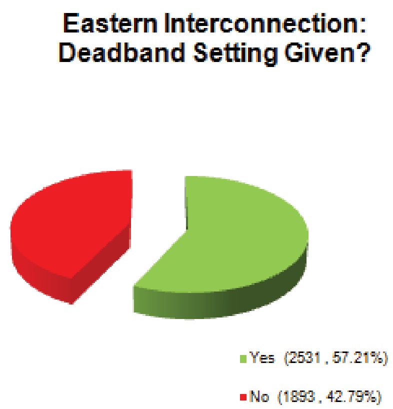


Figure 1

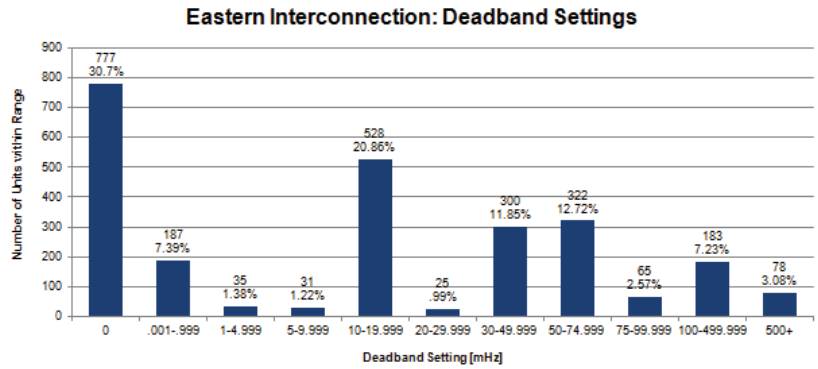


Figure 2

The first goal of this voluntary initiative is to have Eastern Interconnection Balancing Authorities provide an updated Generator Survey Form from their existing generator fleet with confirmed generator data. The data will then be transferred to central repository to be used by Modeling Working Groups. The second goal is to target dates for resetting dead bands to a common target range:

- dead band of +/- 36 mHz,
- droop settings of 3% -5% depending on turbine type,
- continuous, proportional(non-step) implementation of the response
- appropriate operating modes to provide frequency response, and
- appropriate outer-loop controls (distributed controls) settings to avoid primary frequency response withdrawal

The third goal to develop and share tools to measure individual generator performance on multiple frequency events and provide performance metrics results to their generation fleet in an effort to continue to improve Frequency Response.

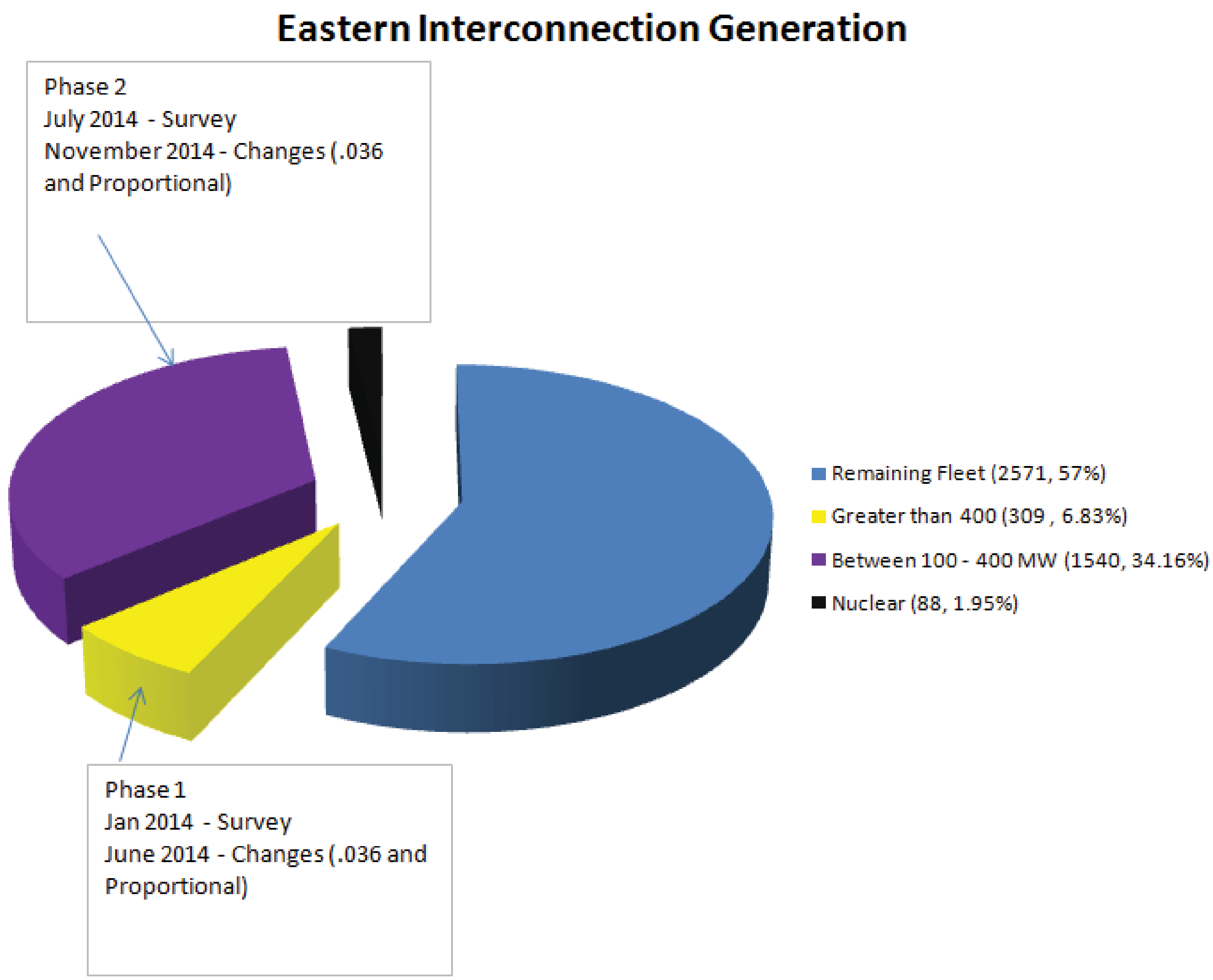
Current Activities:

Several entities have agreed to support this initiative, including MISO, PJM, Duke Energy, TVA, FPL, SCE&G, and SPP. The current plan is:

- All individual generators (including nuclear) 400 MW or larger, BAs will request generators to provide a completed generator survey of governor settings and related data by January 1, 2014. The 400 MW threshold limits this to roughly 7% of all generators in the East.
- All individual generators(excluding nuclear and combined cycle steam turbines) 400 MW or larger, BA’s will request generators to modify all dead bands greater than 0.036 Hz to at most 0.036 Hz and install proportional response if feasible by June 1, 2014. If a generator is unable to meet this timing, the generator is asked to provide reasonable target date to complete this task.

- All individual generators 100 MW to 400 MW, BA’s will request generators to provide a completed generator survey of current governor settings and related data by July 1, 2014.
- All individual generators 100 MW to 400 MW, BA’s will request generators to modify all dead bands greater than 0.036 Hz to at most 0.036 Hz and install proportional response by November 1, 2014. If a generator is unable to meet this timing, the generator is asked to provide reasonable target date to complete this task.

(Figure 3)



Related Documents and Links:

"Frequency Response Initiative Report" October 30, 2012
2010 NERC Generator Data Survey

Revision History:

Date	Version Number	Reason/Comments
10/28/2013	1.0	Initial Version – *"Eastern Interconnection Frequency Initiative"*