

Glossary of terms used in association with Primary Frequency Response

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Area Control Error (ACE) – (from NERC Glossary) - The instantaneous difference between a Balancing Authority’s net actual and scheduled interchange, taking into account the effects of Frequency Bias, correction for meter error, and Time Error Correction . (From M12 - is a measure of the imbalance between sources of power and uses of power within the PJM RTO.)

Automatic Generation Control (AGC) – (from NERC Glossary) - Equipment that automatically adjusts generation in a Balancing Authority Area from a central location to maintain the Balancing Authority’s interchange schedule plus Frequency Bias. AGC may also accommodate automatic inadvertent payback and time error correction.

Critical Load Unit (adapted from PJM Manual 36, System Restoration, Attachment “A”) – units that have a hot start time of 4 hours or less.

Distributed Control System (DCS) - A computerized control system for a process or plant, in which autonomous controllers are distributed throughout the system, but there is central operator supervisory control.

Droop- (from NERC Frequency response Initiative Report, 10/2012) - The expected response of a turbine-generator’s governor to frequency deviations. Droop settings on governors are necessary to enable multiple generators to operate in parallel while on governor control while not competing with each other for load changes.

Dynamic Reserve – (from PJM Glossary) - Used during system restoration to make sure that the system will remain stable if the largest generator trips. Dynamic reserve consists of two components:

(1) Reserve on generators that are available via generator governor action during a frequency disturbance to a level at which generators will normally separate from the system (i.e., 57.5 Hz).

(2) System load with under-frequency trip levels above the frequency at which generators will normally separate from the system during a frequency disturbance (i.e., 57.5 Hz).

Frequency (Area) Regulation {a.k.a. – Regulation} – (adapted from PJM Glossary) - The capability of a specific resource with appropriate telecommunications, control and response capability to increase or decrease its output in response to a regulating control signal to control for frequency deviations and small fluctuations in the generation to load balance. The signal is generated by PJM control center and sent to controllable entities to change generation or demand quickly to keep PJM’s area control error within allowable limits.

Frequency Regulation – (from NERC Glossary) - The ability of a Balancing Authority to help the Interconnection maintain Scheduled Frequency. This assistance can include both turbine governor response and Automatic Generation Control.

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Frequency Response – (from NERC Glossary) – 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).

Frequency Response Obligation – (from NERC Glossary) - The Balancing Authority's share of the required Frequency Response needed for the reliable operation of an Interconnection. This will be calculated as MW/0.1Hz.

Governor – (adapted from NERC Frequency response Initiative Report, 10/2012) - Turbine speed control systems for turbine – generator units to control shaft speed by sensing turbine shaft speed deviations and initiating adjustments to the mechanical input power to the turbine. This control action results in a shaft speed change (increase or decrease).

Governor Deadband - (adapted from NERC Frequency response Initiative Report, 10/2012) – a small “no response” zone within the calibration of the governor speed error bias in order to minimize the movement for very small speed deviations.

Hot Start-up Time (from PJM Markets Gateway User Guide) — The time interval, measured in hours, from the actual unit start sequence to the breaker close for a generating unit in its hot temperature state.

Inertial Response – kinetic energy stored in the rotating mass of all of the synchronized turbine-generators and motors on the interconnection. Produced by the slowing of the spinning inertial mass of rotating equipment on the interconnection that both releases the stored kinetic energy and arrests the decline of the interconnection frequency. This happens immediately following a disturbance

Non-synchronous Generator – a generating resource that is not directly connected to the electrical grid because it does not operate at the same frequency as the grid. Examples are wind and solar farms which in some cases generate DC power which is then converted to AC power via a rectification process. These resources are electronically coupled to the grid.

Primary Frequency Control – (from NERC Frequency response Initiative Report, 10/2012) – 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.

Primary Frequency Response (PFR) – (adapted from NERC Glossary) - Commonly referred to as Frequency Response - The immediate proportional increase or decrease in real power output provided by generating units/generating facilities and the natural real power dampening response provided by

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load in response to changes in system frequency. This happens within the first 60 seconds following a disturbance.

Secondary Frequency Control – (from NERC Reliability Guideline on Primary Frequency Control) - Actions provided by an individual Balancing Authority to correct the resource-to-load imbalance that created the original frequency deviation that will restore both Scheduled Frequency and Primary Frequency Response. Secondary Frequency Control comes from either manual or automated dispatch from a centralized control system such as Automatic Generation Control (AGC). Includes the deployment of area regulation and synchronized reserves (if required). Happens within the recovery period which is 1-10 minutes following a disturbance.

Synchronized Reserve – (adapted from the PJM Glossary) – used to recover the Area Control Error after a resource loss, or to correct for large tie errors or under frequency conditions. Synchronized reserve resources must have the capability to be fully into energy within 10 minutes or customer load that can be removed from the system within 10 minutes of the request from the PJM dispatcher, and must be provided by equipment electrically synchronized to the system.

Synchronous Generator - converts mechanical energy into alternating current electric energy and is connected to the area's electrical grid operating at the same frequency, i.e. synchronized.

Tertiary Frequency Control – (from NERC Frequency response Initiative Report, 10/2012) - 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. - Happens within the period 10 – 60 minutes following a disturbance.

Under Frequency Load Shedding (UFLS) – (adapted from NERC Glossary) - An automatic load shedding program, consisting of distributed relays and controls, used to mitigate underfrequency conditions impacting the Bulk Electric System (BES) which could lead to frequency instability, voltage collapse, or Cascading.