NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Historical Frequency Trends
A Brief for Regulators and Policymakers

ERS Framework[1] Measures 1, 2 & 4 – Historical Frequency Analysis

Frequency support is the response of generators and loads to maintain the system frequency in the event of a system disturbance. Frequency support is provided through the combined interactions of synchronous inertia (traditionally from generators such as natural gas, coal, and nuclear plants as well as from motors at customer locations) and frequency response (from a wide variety of generators and loads). Working in a coordinated way, these characteristics arrest and eventually stabilize frequency. A critical issue is to stabilize the frequency before it falls below underfrequency load shedding values or rises above overfrequency relay trip settings.

It is important to understand that inertia and frequency response are properties of the interconnection (not to each balancing area individually) and these properties have different characteristics for each interconnection. For example, if changes to the resource mix alter the relative amounts of synchronous inertial response or frequency response, various mitigation actions are possible (such as obtaining faster primary frequency response from other generators or loads) to maintain or improve frequency support.

The ERSWG frequency measures are intended to monitor and identify trends in frequency response performance as the generation mix continues to change. The holistic frequency measure, called Measure 4 in ERSWG reports, tracks phases of frequency performance after actual disturbance events in each interconnection (initial frequency rate of change, arresting phase and recovery phase). Other measures look at components of this coordinated frequency response, such as the amount of synchronous inertial response (SIR, Measure 1) and the initial rate of change in frequency following the largest contingency event (RoCoF, Measure 2).

Trends in the frequency measures can be analyzed using historical data. The NERC Resources Subcommittee (RS) is monitoring the historical trends and will be annually reporting on these results in the NERC State of Reliability Report.

Measure 4 is a holistic measure that tracks the system frequency performance following large contingency events that actually occurred in each interconnection. On a quarterly basis, the NERC RS selects the events and calculates values that reflect the minimum/maximum frequency points and the timing of the minimum/maximum frequencies and recovery period. These values are trended from one year to the next as the generation mix changes. The RS is enhancing methods to analyze the findings and trends for these valuable results that show the response to actual events.

[1] Essential Reliability Services Working Group, Measures Framework Report, November 2015

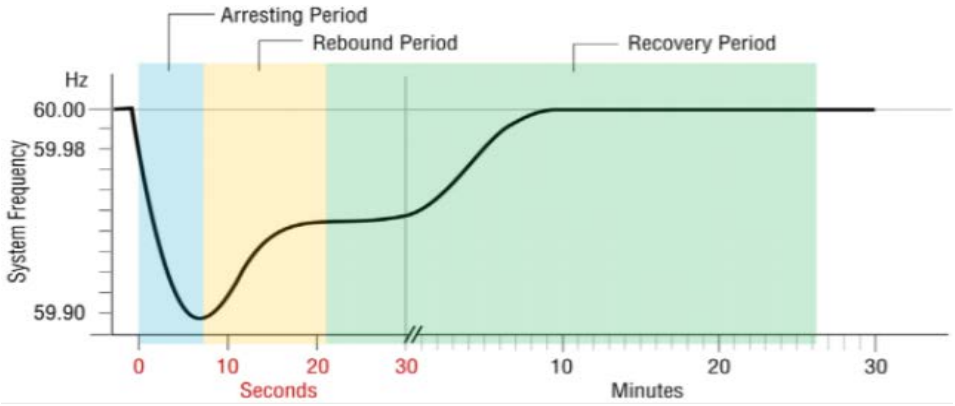

Figure 1. Frequency trace after loss of a generation resource

For historical trending of SIR (Measure 1), a process was established for conducting synchronous inertia calculations for each interconnection. System inertia depends on inertial constant (referred to as 'H') and MVA base2 of the generators that are online and synchronized to the grid at a given point in time. The total SIR for each interconnection can be calculated using data that is now being collected on an ongoing basis. This data is currently provided to the NERC RS on a quarterly basis. A platform is being developed to facilitate the direct submission of the data to NERC. The NERC RS will analyze the data and provide reports on trends each year.

RoCoF (Measure 2) is an alternative way to look at inertia. It can be calculated from the SIR value obtained in Measure 1 and the size of the largest contingency event for the interconnection (the Resource Contingency Criteria as defined in the BAL-003 Standard – this is usually the largest generator online). The RoCoF value and the load shedding values for the interconnection can be used to calculate the time during which sufficient frequency response must be provided to the interconnection. If the necessary time for response is decreasing, there may be value in obtaining faster frequency response from generators and loads. As with SIR, RoCoF trends will be analyzed by the NERC RS each year.

For Further Information

For more details on this topic, see Chapter 1 of the ERS Whitepaper on Sufficiency Guidelines. The ERS Working Group is currently working with the NERC RS on the forward-looking projections for Measures 1, 2 and 4. These planning methods, which will supplement the historical methods described above, will be the subject of a separate Brief for Regulators and Policymakers. The NERC RS will summarize the forward looking projections annually in the NERC Long Term Reliability Assessment Report.

[2] To be precise, the inertial constant depends on the size, weight, nominal speed of the generator. MVA base is used to normalize the inertia constant. The generator's nameplate rating is usually (but not always) chosen as MVA base. SIR does not depend on a plant's output level, but on whether it is synchronized to the grid.