ERS Measures M1-M4 Forward Looking Project Plan DRAFT

NERC Essential Reliability Services Working Group (ERSWG) Frequency Sub-Group
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Purpose

This short white paper provides the technical background and direction for assessing the Essential Reliability Services (ERS) Measures M1-M4. This discussion focuses on the forward-looking analysis for the measures, which will complement the historical data analysis for the same measures.

Measure M1: Interconnection Synchronous Inertia

Measure M1 analyzes the interconnection synchronous inertia value. In the forward-looking horizon, the best approach is to use the interconnection-wide models available for dynamic simulations that include the necessary information.

Each interconnection-wide, dynamics ready case is composed of a dynamics file that includes the inertia values for each unit in the case. The units that are committed and dispatched in that case will have a corresponding inertia constant and those can be reported to determine the total interconnection-wide inertia value.

Inertia is calculated as

$$Inertia_{Synchronous} = \sum H * MBASE$$

This simply means that the inertia constant value is multiplied by the MVA base of the machine to get the synchronous inertia value, expressed as MVA*s. Automation scripts (Python, epcl) can be created to extract this information with ease.

The selection of the interconnection-wide cases is the aspect that needs attention. The case should reasonably reflect a “low system inertia” condition. This is predominantly driven by light load, high wind, /solar conditions where synchronous inertia is at its lowest. Table 1 provides information related to the cases that plan to be used. The cases will be collected in coordination with the MOD-032 Designees and associated parties – Western Electricity Coordinating Council (WECC), Texas Reliability Entity, Inc. (Texas RE) along with Electric Reliability Council of Texas, Inc. (ERCOT), and Multiregional Modeling Working Group (MMWG) with Hydro Quebec.

Table 1: Base Cases for M1 Assessment		
Interconnection	**Case Names**	**Notes**
Eastern	Year 1: Year 3: Year 5:	
Quebec	Year 1: Year 3: Year 5:	
Texas	Year 1: Year 3: Year 5:	
Western	Year 1: Year 3: Year 5:	

ERCOT creates a dynamics-ready case based on economic dispatch representative of low synchronous inertia conditions. Quebec also creates a case that is representative of its restricted operating conditions around primary frequency response and inertia concerns. The Western and Eastern Interconnections generate interconnection-wide cases that should be reflective of a reasonable dispatch for the operating conditions under study (e.g., spring light load). These are the cases that will be used for analysis.

Once NERC acquires the cases, minimal modifications to the cases will be performed (e.g., modifying commitment and dispatch, demand levels, etc.). The "off-the-shelf" cases as provided by the MOD-032 Designees will be used to perform the analysis.

Measure M2: Rate of Change of Frequency

M2 analyzes the rate of change of frequency (ROCOF) at the minimum synchronous inertia conditions. The ROCOF will be calculated as the rate of change of frequency within the first 0.5 seconds following the disturbance on the system[1].

$$ROCOF_{0.5} = \frac{f_{0.5} - f_0}{t_{0.5} - t_0} = \frac{f_{0.5} - f_0}{0.5}$$

where $f_{0.5}$ and f_0 are the frequency measurements at time $t_{0.5}$ and t_0. The median frequency measurement collected and provided by the FNET system will be used as the "system frequency" measurement for which the M2 ROCOF calculation will be applied. The ROCOF within the first 0.5 seconds captures system

[1] Rate of change of frequency is df/dt, the approximation as $\Delta f/\Delta t$ is only valid for a small Δt

inertial movement prior to the majority of primary frequency response from generation and load. Therefore, it can be correlated or discussed in respect to system inertia.

The ROCOF calculation will be applied to the Resource Contingency Criteria (RCC) for each interconnection, as determined by the NERC Frequency Working Group (FWG). The current RCC for each interconnection is provided in Table 2. The values defined correspond to select contingencies used for BAL-003-1.1 requirements and interconnection frequency response obligations (IFRO). If operating restrictions would limit the RCC, then that will be accounted for as part of the case creation and contingency definition. For example, Hydro Quebec limits generation dispatch for low inertia conditions such that 1700 MW RCC cannot occur. This mitigates a potential severe contingency where inertial conditions are of concern.

Table 2: Resource Contingency Criteria (RCC) for Each Interconnection

Texas	Eastern	Western	Quebec
2750 MW	4500 MW	2740 MW	1700 MW

The ROCOF may also be calculated, as time permits, on select contingencies of interest that occurred in the backward-looking horizon. These contingencies would be selected based on their size, contingency definition, and mapping back to a system condition represented by a forward-looking base case.

Measure M3: BA Synchronous Inertia

M3 is very similar to M1, except that it is calculated on a smaller area basis. The backward-looking assessment for M3 uses BA data for measuring synchronous inertia. This is due to the availability of the data and reporting structure at NERC. However, BA information is not easily attainable for the forward-looking assessment. Therefore, a modified approach will be used that continues to use the interconnection-wide cases developed for future looking analysis. Those cases contain an “Area”, “Zone”, and “Owner” field used for various reasons in the cases. The “Area” field is not a 1:1 match to BA footprint; however, the Areas will be combined into NERC Assessment Areas[2] and data for inertia can be extracted in this manner.

The same set of cases and assumptions used for M1 will apply to M3. The only difference is reporting on a NERC Assessment Area basis. While BA- or NERC Assessment Area-wide synchronous inertia is not particularly relevant or useful in the context of a changing resource mix and ERS, it is a useful data point to collect for trending to understand how the interconnection’s BAs or Areas are changing over time in terms of synchronous inertia.

Note that for the Texas and Quebec Interconnections, M1 and M3 are the same since the BA and the interconnection footprint are equivalent.

Measure M4: Interconnection Frequency Response

[2] These combinations of Areas will not be a direct mapping to the NERC Assessment Areas used in the Long Term Reliability Assessment but will be a close approximation of these Assessment Areas.

M4 is a set of sub-measures or calculations that can be applied to any measurement, either from actual system data or from a simulation. The sub-measures use a time range of 16 seconds before the contingency to 52 seconds after the contingency. For simulations, where frequency starts at nominal value, the time range can be from the point of contingency to 52 seconds after since frequency remains constant until the contingency occurs. The cases from M1 (and M3) will be used for the analysis. The contingencies from M2 for the RCC will be used for the simulation. The M4 sub-measures will be applied to the median frequency signal derived from frequencies across the interconnection in the simulation. This will be performed by extracting a number of frequency measurements from the simulation and then taking a median value of those signals. This approach will closely map to the way FNET calculates its system frequency measurement.

The M4 measure may be tested, as time permits, on select contingencies of interest as specified in M2. These contingencies would be selected based on their size, contingency definition, and mapping back to a system condition represented by a forward-looking base case. A forward-looking base case would be selected that matches the general operating conditions for that event, as provided by the MOD-032 Designee.