

<b>M-4.1</b>			
Inertia and Rate-of-Change-of-Frequency			
<b>Submittal Date</b>	Accepted March 16, 2022 November 30, 2021		
<b>Proposal Type</b>	New <input checked="" type="checkbox"/>	Revision <input type="checkbox"/>	Metric Analysis <input type="checkbox"/>
<b>Definition</b>	The metric will track and monitor Interconnection Frequency Response between the starting frequency (A-point) and the lowest nadir frequency (C-point).		
<b>Rating Criteria</b>	<ul style="list-style-type: none"> <li>• <b>Red (actionable):</b> Any statistical decline in the arresting period rolling five-year time trend or any instance of Under Frequency Load Shedding (UFLS) activation due to a sudden generation loss</li> <li>• <b>Yellow (monitor):</b> Two or more consecutive years of decline in the arresting period, but statistically stable in the rolling five-year time trend</li> <li>• <b>White (stable):</b> Statistically stable in the arresting period rolling five-year time trend, with no more than one year below the rolling five-year average</li> <li>• <b>Green (good/improving):</b> Statistical improvement in the arresting period rolling five-year time trend</li> </ul> <p>How will it be suited to indicate performance: Inertia is the tendency of the system to maintain 60 Hz during a disruption without any resource response. It is an essential component for the reliable operation of the bulk power system, particularly during disturbances and restoration. With the changes in resource mix to more renewable resources, inertia provided by traditional mechanical synchronous machines will be replaced by synthetic inertia provided by electronic power converters.</p> <p>Without sufficient system inertia, loss of resource events that result in low frequency can quickly degrade (as measured by Rate of Change of Frequency (RoCoF) and result in tripping of the first stage of under frequency load shed (UFLS) before resources that provide primary frequency response can respond.</p>		
<b>Purpose</b>	With the changes in generation resource mix, there is evidence of a decline in inertia in the different interconnections.		

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	<p>In the BAL-003-2 Standard, the Interconnection Frequency Response Obligation (IFRO) is calculated on the basis that frequency will be arrested above the first stage of UFLS for the Interconnection Resource Loss Protection Criteria (RLPC).</p> <p>The Interconnection A-C Frequency Response metric data will measure the ability of the Interconnection to arrest a frequency decline before it reaches the first stage of UFLS. Trends and analysis of this data will assist in assessing the impact of changing resource mix and the decline in inertia for the interconnections, as well as identify if additional actions may be needed to assure adequate frequency response in North America.</p>
<b>Formula or Type of Statistical Analysis</b>	Average and median A-C frequency response for all events selected by the NERC Frequency Working Group (FWG) via the Resources Subcommittee.
<b>Time Horizon</b>	Historic view
<b>Metric Start Time or Baseline</b>	2015 or when data is first available
<b>Data Collection Interval and Roll Up</b>	Interconnection A-C Frequency Response will be calculated from the same events selected for the M-4 metric. M-4 frequency events are selected quarterly by the Frequency Working Group (FWG) utilizing event selection criteria defined in the FWG Frequency Event Selection Process Document. The M-4 frequency event Operating Year is from December 1st through November 30th.
<b>Ease of Collection</b>	<p>The Interconnection A-C Frequency Response metric will utilize the same data sources currently used for the M-4 metric.</p> <p>Frequency data for all four Interconnections are available to NERC staff through the University of Tennessee by using the Frequency Monitoring Network (FNet). The data consists of sub-second high-speed frequency values (10 samples per second) captured by FNet’s frequency disturbance recorders. Phasor Measurement Unit (PMU) may also be used, if available, for each Interconnection.</p>

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<b>Aggregation</b>	Interconnection					
<b>Links to NERC Standard</b>	BAL-003-2					
<b>Data Source</b>	10 samples per second FNET data from the University of Tennessee Knoxville (UTK) and other NERC data sources as validated by the Frequency Working Group (FWG) via the Resources Subcommittee. This became effective on December 1, 2020.					
<b>Data Source Owner</b>	Resource Subcommittee					
<b>Data to be Submitted By</b>	Balancing Authorities					
PAS and NERC Staff Use						
<b>Need for Validation or Pilot</b>	N/A					
<b>SMART Rating</b> PAS SMART rating of proposed metric, metric revision, or new metric analysis method	Total Score	Specific/Simple	Measurable	Attainable	Relevant	Tangible/ Timely
	14	2	3	3	3	3
<b>Publications and Documentation</b>	PAS and NERC staff decide if metric reported in SOR report or other NERC publication. Style: Scatter plots and box plots of Interconnection A-C Frequency Response trends with linear regression for a minimum three-year period. Tables with minimum Interconnection A-C Frequency Response by year for the entire available dataset.					