

## Resource Reliability Attribute & Additional Attribute Description

### Inertia

Inertia refers to the energy stored in large rotating generators and is a factor in helping to minimize a frequency drop if/when a sudden loss of generation occurs. This minimizes the nadir or the frequency drop immediately following the disturbance.

### Primary Frequency Response (PFR)

PFR is the inherent response of resources and load to locally detect and arrest changes in frequency. It is an automatic, locally detected response by resources that is not driven by any centralized system and begins within seconds after a frequency excursion. It is essential to stopping a decline in frequency and preventing the activation of automatic under-frequency load shedding (UFLS). The fast, inherent response is a larger differentiator between PFR and regulation, the latter of which follows a centralized dispatch signal from PJM.

### Reactive Capability and Supply

The mechanical capability for a generator to provide supply reactive support to the grid and the actual supply of reactive as needed. i.e. the ability to follow a voltage schedule.

\*consider how to incorporate the word 'performance'

	1 Is there an existing FERC, NERC or PJM requirement for generators to provide this attribute (e.g., Tariff, Manual, NERC Standard)?	2 Is there an existing PJM Market Product in place to maintain a minimum amount of generation that can provide this attribute?	3 Do other ISO/RTOs have an existing Market Product in place to maintain a minimum amount of generation that can provide this attribute?	4 Is there an active PJM PS/IC to address concerns with adequate availability of this attribute for operational needs?	5 Does the changing resource mix, including announced retirements, warrant a change to how we satisfy this attribute within the next 5 years?	6 Is there a concern raised within the OC that we agree needs to be addressed within the 5 years? Is there a longer-term concern?
<b>Inertia</b> Inertia refers to the energy stored in large rotating generators and is a factor in helping to minimize a frequency drop if/when a sudden loss of generation occurs. This minimizes the nadir or the frequency drop immediately following the disturbance.	There are no requirements for resource to provide inertia.	No.	<b>ERCOT has a product for very fast frequency response that is arguably inertia-like;</b> AESO (when they island).	No.		
<b>Primary Frequency Response (PFR)</b> PFR is the inherent response of resources and load to locally detect and arrest changes in frequency. It is an automatic, locally detected response by resources that is not driven by any centralized system and begins within seconds after a frequency excursion. It is essential to stopping a decline in frequency and preventing the activation of automatic under-frequency load shedding (UFLS). The fast, inherent response is a larger differentiator between PFR and regulation, the latter of which follows a centralized dispatch signal from PJM.	<ul style="list-style-type: none"> <li>• FERC Order 842 requires all resources, traditional and Inverter Based Resources (IBRs), to be <b>capable</b> of providing PFR and <b>operating</b> with PFR controls enabled. The order does not require resources to maintain operational headroom or foot room such that PFR up or down is always available.</li> <li>• NERC BAL-003 sets a Frequency Respond Obligation (FRO) for each BA.</li> </ul>	No.	Yes – ERCOT as an example does have a PFR market product. The WECC has seen bilateral trades of PFR.	Per PJM Manual 12 requirements, PJM does monitor frequency response and reports to the OC. If a concern was identified, the PFRSTF could be reactivated.		
<b>Reactive Capability and Supply</b> The <u>mechanical capability</u> for a generator to <u>provide supply</u> reactive support to the grid and <u>the actual supply of reactive as needed. i.e. the ability to follow a voltage schedule.</u>  <u>*consider how to incorporate the word 'performance'</u>	<ul style="list-style-type: none"> <li>• FERC and PJM Requirements to have reactive capability. PJM ISA: <ul style="list-style-type: none"> <li>– min PF of 0.95 lead/0.90 lag (synchronous)</li> <li>– min PF of 0.95 lead/0.95 lag (non-synchronous)</li> </ul> </li> <li>• VAR-002 does require units to operate with their AVR in-service and follow a voltage schedule.</li> </ul>	No, but there is a compensation mechanism.	No.	The Reactive Power Compensation Task Force is currently active and “will evaluate the standards for the provision of reactive service and the mechanism that provides for the opportunity to be compensated for reactive service.”		

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<p><b>Ramping</b> Ramping is upward or downward control by resources over a period of time needed to maintain load-generation balance. This is most needed at times of major load shifts, especially during the winter evening ramps, when increases in load coincide with decreases in solar output, and are potentially amplified by wind output changes.</p>	Not directly.	No.	Yes – CAISO does have a ramping product.	No.		
<p><b>Regulation</b> Regulation is the requirement of generators to control Area Control Error (ACE) and frequency deviations.</p>	No.	Yes – Reg A and Reg D.	Yes, including several Reg Up and Reg Down products in MISO, SPP, ERCOT and CAISO.	A PJM PS/IC was approved to redesign regulation market. Work will begin in 2Q22. This will include market design, signal design and regulation requirements.		
<p><b>Flexibility</b> Flexibility is a reliability attribute that measures the ability of a unit to turn on and off quickly and frequently in a single operating day. Three characteristics that commonly determine a resource’s flexibility are cycling capability, quick-start time and low minimum run times.</p>	Yes – PJM Capacity Performance requires units to operate to their “physical parameters” when offer capped or during Tariff/Manual defined emergencies.	Not directly, with the exception of the existing ancillary service markets that incent fast start and ramping capability for synch, primary and operating reserve.	Quick start only.	No.		
<p><b>Fuel Assurance</b> Fuel assurance considers the ability of a balancing authority to withstand disruptions to fuel supply chains and delivery mechanisms that hinder generator performance (i.e., cold weather performance in 2014). PJM’s Evolving Resource Mix and System Reliability paper defined fuel assurance as “the ability of a resource to maintain economic maximum energy output for 72 hours, based on the definition of fuel-limited resources within the PJM Manual 13: Emergency Operations Attachment C.”</p>	No, but Capacity Performance is intended to incent fuel assurance.	RPM assumes fuel assurance.	ISO-NE has worked to incorporate a fuel-security reliability review methodology into its Forward Capacity Market. ISO-NE has also considered the inclusion of opportunity costs in energy market supply offers for oil and dual-fuel resource with limited energy production and improved energy emergency forecasting and reporting protocols.	The annual Fuel Security Analysis is reviewed by the OC and MRC to identify any fuel and energy assurance concerns.		

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### Energy Assurance

Energy assurance refers to the concept of managing energy assurance to account for variability in solar irradiance and wind speed. This is a factor for both longer-term planning as well as near-term operations

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<ul style="list-style-type: none"> <li>No, but the RPM auction does utilize an ELCC model to help to more accurately reflect the capacity contribution of renewable resources.</li> <li>Renewable resources are required to provide meteorological data and solar irradiance data for PJM's renewable forecasts.</li> </ul>	The Day-Ahead and RT Markets.	Yes – DA and RT Markets.	The annual Fuel Security Analysis is reviewed by the OC and MRC to identify any fuel and energy assurance concerns.		
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### Black Start

Black start capability is necessary to restore the PJM transmission system following a system-wide blackout. PJM black start resources are able to self-start and close to a de-energized bus within three hours without electrical assistance from the grid or stay online and operate at reduced levels when automatically disconnected from the grid.

No. NERC Standards only apply to generators that are black start. They do not require any specific generator or MW amount of generation to have black start capability.	No. Only cost recovery.	No.	No.		
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### System Stability

System stability refers to three perspectives:

1. Transient (angular) stability
2. Small signal stability, which is a degree of damping performance
3. Voltage stability, which looks at dynamic voltage recovery performance

<ul style="list-style-type: none"> <li>NERC PRC-024 requires specific voltage and ride through capabilities.</li> <li>IEEE standard for non-BES IBRs.</li> </ul>	No	No.	No.		
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### Dispatchability

The ability for a generator to receive and respond, in real time, to a dispatch signal to adjust the MW output of the resource.

No.	No.		Yes. Approved OC 1/13.		
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### Extreme Weather Performance

The ability for generators to perform under extreme weather conditions such as extreme heat, extreme cold, high wind, icing, etc.

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