**ERCOT Nodal Operating Guides**

**Section 8**

**Attachment C**

**Turbine Governor Speed Tests**

**December 5, 2025**

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Turbine Governor Speed Regulation Test for Mechanical-Hydraulic Governor

***General Information***

Unit Code (16 characters): Location (County):

Unit Name: Date of test:

QSE: Resource Entity:

***Steady State Speed Regulation at High-Speed Stop***



Where:

A = Speed with speed changer set at high-speed stop and with throttle (or stop) valves open and machine running idle on the Governor.

B = Speed with speed changer set at high-speed stop and when governing valves just reach wide-open position.

***Steady State Speed Regulation at Synchronous Speed*** *[[1]](#footnote-1)*



Where:

C = Speed with speed changer set for synchronous speed and with throttle (or stop) valves open and machine running idle on the Governor.

D = Speed with speed changer set at the same position as in C above and when governing valves just reach wide open position.

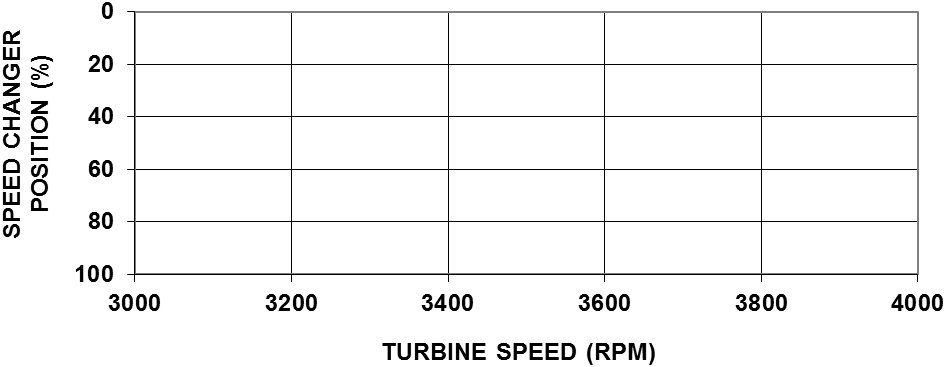
***Steady State Speed Regulation at Low-Speed Stop***



Where:

E = Speed with speed changer set at low-speed stop and with throttle (or stop) valves open and machine running idle on the Governor.

F = Speed with speed changer set at low-speed stop and when governing valves just reach wide-open position.



E, F @ Low Speed Stop

C, D @ Sync. Speed

A, B @ High Speed Stop

**Test Data**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Point** | **A** | **B** | **C** | **D** | **E** | **F** |
| Speed, RPM |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| Frequency Hz |  |  |  |  |  |  |

**Speed Changer Travel Time:**

(a) From Low-Speed Stop to High-Speed Stop in \_\_\_\_\_\_\_\_\_seconds.

(b) From High-Speed Stop to Low-Speed Stop in \_\_\_\_\_\_\_\_\_seconds.

Over-speed Trip Test Speed at \_\_\_\_\_\_\_\_\_rpm.

Comments:

***Submittal***

Resource Entity Representative:

QSE Representative:

Date submitted to ERCOT Representative:

Example of a Turbine Governor Speed Regulation Test for Mechanical-Hydraulic Governor

***Steady State Speed Regulation at High-Speed Stop***



Where:

A = Speed with speed changer set at high-speed stop and with throttle (or stop) valves open and machine running idle on the Governor.

B = Speed with speed changer set at high-speed stop and when governing valves just reach wide-open position.

***Steady State Speed Regulation at Synchronous Speed [[2]](#footnote-2)***



Where:

C = Speed with speed changer set for synchronous speed and with throttle (or stop) valves open and machine running idle on the Governor.

D = Speed with speed changer set at the same position as in C above and when governing valves just reach wide open position.

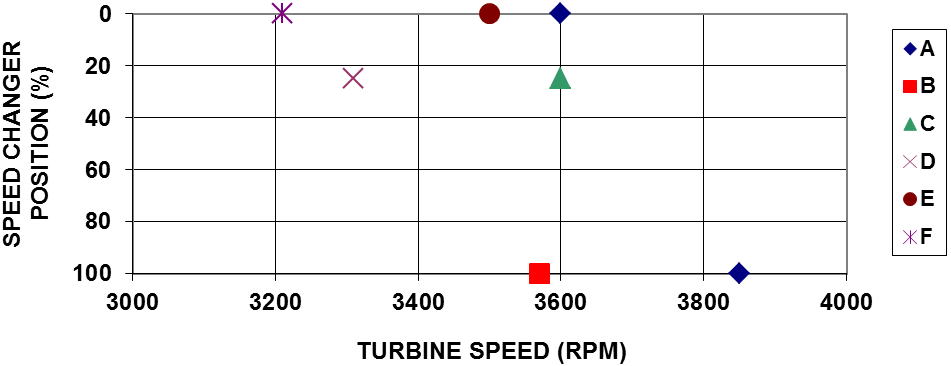
***Steady State Speed Regulation at Low-Speed Stop***



Where:

E = Speed with speed changer set at low-speed stop and with throttle (or stop) valves open and machine running idle on the Governor.

F = Speed with speed changer set at low-speed stop and when governing valves just reach wide-open position.



E, F @ Low Speed Stop

C, D @ Sync. Speed

A, B @ High Speed Stop

**Test Data**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Point** | **A** | **B** | **C** | **D** | **E** | **F** |
| Speed, RPM | 3850 | 3570 | 3600 | 3310 | 3500 | 3210 |
|  |  |  |  |  |  |  |
| Frequency Hz | 64.2 | 59.5 | 60.0 | 55.0 | 58.3 | 53.5 |

**Speed Changer Travel Time:**

(a) From low-speed stop to high-speed stop in 73 seconds.

(b) From high-speed stop to low-speed stop in 74 seconds.

Over-speed trip test speed at 3965 rpm.

Comments:

**Turbine Governor Speed Regulation Test for Electro-Hydraulic Governor**

***General Information***

Unit Code (16 characters): Location (County):

Unit Name: Date of test:

QSE: Resource Entity:

***Turbine Governor Speed Regulation Test Procedures***

(a) Simulate unit On-Line and turbine speed at 3600 RPM.

(b) Set Load reference at minimum value.

(c) Monitor valve demand signal and record as value “A” (in %).

(d) Reduce speed until valve demand just reaches maximum value.  
Record valve demand as value “B” (in %) and speed as value “C” (in RPM).

(e) Set speed at 3600 and Load reference at maximum value.

(f) Monitor valve demand signal and record as value “D” (in %).

(g) Increase speed until valve demand just reaches minimum value.  
Record valve demand as value “E” (in %) and speed as value “F” (in RPM).

***Turbine Governor Speed Regulation Test Results***

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **A** | **B** | **C** | **D** | **E** | **F** |
| Valve Demand (%) |  |  |  |  |  |  |
| **Speed (rpm)** |  |  |  |  |  |  |

***Speed Regulation With Decreasing Speed***



***Speed Regulation With Increasing Speed***



Comments:

***Submittal***

Resource Entity Representative:

QSE Representative:

Date submitted to ERCOT Representative:

**Definitions**

|  |  |
| --- | --- |
| **System Frequency Response** | This response is a function of two key variables: the Primary Frequency Response from Governors and Load dampening of the connected Load. |
| **Percent Droop Settings** | Also known as Frequency Regulation, Speed Regulation, Speed Sensitivity, Speed Error and others. Percent droop is the percent change in nominal frequency that will cause generator output to change from no Load to full Load. For synchronous Resources, it is the change in steady state rotor speed, expressed in percent of rated speed, when power output is gradually reduced from rated to zero power. A common percent droop setting is 5% for both high and low frequency excursions. |
| **Dead-Band** | The range of deviations of system frequency (+/-) that produces no Governor response, and therefore, no frequency (speed) regulation. It is expressed in percent of rated speed, Hz, or RPM. |
| **Valve Position Limiter** | A device that acts on the speed and Load governing system to prevent the Governor-controlled valves from opening beyond a pre-set limit. |
| **Blocked Governor Operation** | Operating the generating unit with the control system adjusted to prevent the turbine governor from responding to system frequency (speed) variations. In an effort to reduce speed Governor operation in some generating units, turbine control systems can be adjusted to block the operation of the Governor after the unit is in parallel with the system and is running at its desired output. Selection of a high percent droop characteristic or a large Governor Dead-Band constitutes a form of blocked Governor action. |
| **Variable Pressure Operation** | Varying the boiler pressure to improve turbine efficiency at lower Loads. Two methods are normally used. The first method, the turbine control (G.E.) or Governor (Westinghouse) valves are positioned in the wide-open position and the generator is changed by changing the boiler pressure. With this method, there is very little, if any response to frequency excursions. The second method, the valves are positioned at approximately 50% open. The valves are still able to respond to system disturbances. Normal changes in generation requirements are made by varying the boiler pressure until the unit is at rated pressure. After full pressure is reached, the turbine valves are used to make the required generation changes. |

Generation Resource Frequency Response Test Procedure

***Description of the Test***

1. The frequency response function of the Generation Resource is tested On-Line at a Load level that allows the Generation Resource to increase or decrease Load without reaching low operating limits or high operating limits. If the Generation Resource cannot be tested On-Line then it will notify ERCOT that it will be conducting an Off-Line test. The recommended level is 92% Base Load or below.

2. The test is performed by adding a frequency offset signal that exceeds the Governor Dead-Band value to the measured frequency signal. This should create immediate step change in the measured frequency signal.

3. The test starts at time t0 when the frequency Dead-Band is exceeded and signal “Generation Resource Frequency Response On” becomes active.

4. The following signals should be recorded at least two seconds: Unit MW Output, “Generation Resource Frequency Response On.”

5. The duration of the test is 100 seconds. After 100 seconds, the offset signal should be removed and the Generation Resource should return to pretest power output.

6. The test should be conducted both with positive and negative frequency offsets.

7. The test is considered successful after the signal becomes active if at least 70% of the calculated MW contribution is delivered within 16 seconds and the response is maintained for an additional 30 seconds.

8. Governor droop and Governor Dead-Band settings shall be set in accordance with Section 2.2.7, Turbine Speed Governors.

***Definitions***

**Generation Resource Base Load =** Maximum Droop Response Range (MDRR)

**Gain MW for 0.1Hz** = 

Where:

*P* = Generation Resource Base Load (MW)

*Droop* = droop (%)

**Frequency Offset** = +0.2 Hz and -0.2 Hz (+12 rpm and -12 rpm, for 3600 sync speed machines), outside Governor Dead-Band

**Test frequency** = Measured Frequency + Frequency Offset

**MW Contribution** = Gain MW to 0.1 Hz \*10\*Frequency Offset

**Calculated droop** = - 

Where:

P = Generation Resource Base Load (MW)

ΔHz = Change in frequency (Hz), taking into account Governor Dead-Band

ΔMW = Change in power output (MW)

***Example***

Generation Resource Base Load = 150 MW

Droop = 0.05 or 5% (use 0.05 for calculation)

Governor Dead-Band = 0.034

Gain MW to 0.1 Hz =  = +/- 5.06 MW/0.1 Hz

MW Contribution = 5.06\*10\*+/- (0.2) = +/-10.12 MW

Expected under-frequency response: +10.12 MW in 16 sec. for -0.2 Hz offset

Expected over-frequency response: -10.12 MW in 16 sec. for +0.2 Hz offset

Minimum accepted under-frequency response: +7.08 MW in 15 sec. for -0.2 Hz offset

Minimum accepted over-frequency response: -7.08 MW in 15 sec. for +0.2 Hz offset

Calculated droop for 8 MW increase in power output in 16 sec. for -0.2 Hz offset:

Calculated droop = - = 0.0625 or 6.25%

**Generation Resource FREQUENCY RESPONSE TEST FORM**

***General Information***

Unit Code (16 characters): Location (County):

Unit Name: Date of Test:

QSE: Resource Entity:

***Test Results***

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | **Test with +0.2 Hz** | **Test with -0.2 Hz** |
| **1** | **Generation Resource Base Load** |  |  |
| **2** | **GAIN MW to 0.1Hz** |  |  |
| **3** | **Calculated**  **MW Contribution** |  |  |
| **4** | **MW at test start (t0)** |  |  |
| **5** | **MW at t0 + 16 sec** |  |  |
| **6** | **MW Contribution**  **at t0 + 16 sec** |  |  |
| **7** | **MW at t0 + 46 sec** |  |  |
| **8** | **Calculated droop** |  |  |
| **9** | **CONCLUSION**  **(PASSED/FAILED)** |  |  |

***Comments***: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

***Submittal***

Resource Entity Representative: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

QSE Representative: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date submitted to ERCOT Representative: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Energy Storage resource Frequency Response Test Procedure

***Description of the Test***

1. An Energy Storage Resource (ESR) is tested On-Line in both maximum charging and discharging modes at a level that allows the ESR to increase or decrease Load without reaching its operating limits. If the ESR cannot be tested On-Line then it will notify ERCOT that it will be conducting an Off-Line test.

2. The test is performed by adding a frequency offset signal that exceeds the Governor Dead-Band value to the measured frequency signal. This should create an immediate step-change in the measured frequency signal.

3. The test starts at time t0 when the frequency dead-band is exceeded.

4. The following signals should be recorded for at least two seconds: unit MW level and frequency offset signal.

5. The duration of the test is 100 seconds. After 100 seconds, the offset signal should be removed and the Energy Storage Resource should return to the pretest MW level.

6. The test should be conducted with both positive and negative frequency offsets.

7. The test is considered successful after the signal becomes active if at least 70% of the calculated MW contribution is delivered within 16 seconds and the response is maintained for an additional 30 seconds.

8. Governor droop and Governor Dead-Band settings shall be set in accordance with Section 2.2.7, Turbine Speed Governors.

***Definitions***

**Energy Storage Resource Base Load =** MDRR for low frequency test and for high frequency test

**Gain MW for 0.1Hz** =

10

\*

)

60

\*

(

*Band*

*GovernorDead*

*Droop*

*P*





Where:

*P* = Energy Storage Resource Base Load (MW)

*Droop* = droop (%)

**Frequency Offset** = +0.2 Hz and -0.2 Hz (+12 rpm and -12 rpm, for 3600 sync speed machines), outside Governor Dead-Band

**Test frequency** = Measured Frequency + Frequency Offset

**MW Contribution** = Gain MW to 0.1 Hz \*10\*Frequency Offset

**Calculated droop** = -



Where:

P = Energy Storage Resource Base Load (MW)

ΔHz = Change in frequency (Hz), taking into account Governor Dead-Band

ΔMW = Change in power level (MW)

***Example***

Energy Storage Resource Base Load = 150 MW, when discharging

Droop = 0.05 or 5% (use 0.05 for calculation)

Governor Dead-Band = 0.017

Gain MW to 0.1 Hz = = +/- 5.03 MW/0.1 Hz



MW Contribution (injection) = 5.03\*10\*+/- (0.2) = +/-10.06 MW

Expected under-frequency response (injection): +10.06 MW in 16 sec. for -0.2 Hz offset

Expected over-frequency response (withdrawal): -10.06 MW in 16 sec. for +0.2 Hz offset

Minimum accepted under-frequency response (injection): +7.04 MW in 15 sec. for -0.2 Hz offset

Minimum accepted over-frequency response (withdrawal): -7.04 MW in 15 sec. for +0.2 Hz offset

Calculated droop for 8 MW increase in power output in 16 sec. for -0.2 Hz offset:

Calculated droop = - = 0.0625 or 6.25%



**Energy Storage Resource FREQUENCY RESPONSE TEST FORM**

***General Information***

Unit Code (16 characters): Location (County):

Unit Name: Date of Test:

QSE: Resource Entity:

***Test Results***

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | **Test with +0.2 Hz** | **Test with -0.2 Hz** |
| **1** | **Energy Storage Resource (ESR) Base Load** |  |  |
| **2** | **GAIN MW to 0.1Hz** |  |  |
| **3** | **Calculated**  **MW Contribution** |  |  |
| **4** | **MW at test start (t0)** |  |  |
| **5** | **MW at t0 + 16 sec** |  |  |
| **6** | **MW Contribution**  **at t0 + 16 sec** |  |  |
| **7** | **MW at t0 + 46 sec** |  |  |
| **8** | **Calculated droop** |  |  |
| **9** | **CONCLUSION**  **(PASSED/FAILED)** |  |  |

***Comments***: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

***Submittal***

Resource Entity Representative: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

QSE Representative: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date submitted to ERCOT Representative: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Generation Resource, Energy Storage Resource, and Controllable Load Resource Primary Frequency Response test Procedures Based on Historical Data**

***Description of Historical Verification***

The purpose of this template is to allow the Entity that operates a Generation Resource, Energy Storage Resource (ESR) or a Controllable Load Resource (CLR) to demonstrate acceptable frequency response of its Generation Resource(s), ESR(s) or CLR(s) based on historical data in order to minimize testing costs, scheduling conflicts and the risk of damage to equipment or Forced Outage.

1. All verifications will be based on at least one of the events from the published list of Frequency Measurable Events (FMEs).

2. Governor droop and Governor Dead-Band settings shall be set in accordance with Section 2.2.7, Turbine Speed Governors.

3. For clarification purposes, the time of FME (t(0)), pre-perturbation average frequency and post-perturbation average frequency, as defined in Section 8, Attachment J, Initial and Sustained Measurements for Primary Frequency Response, will be used for the verification process. The values of these metrics will be identified in the FME Report.

4. The test is considered successful if the Generation Resource, ESR, or the CLR is able to meet a minimum of 75% of its initial Primary Frequency Response and 75% of its sustained Primary Frequency Response as calculated in the FMEs report posted on the Market Information System (MIS) Certified Area. Any Generation Resource, ESR, or CLR may use the FME report in lieu of testing.

a. The calculation of Generation Resources, ESRs, or CLRs initial and sustained Primary Frequency Response is detailed in Section 8, Attachment J.

b. ERCOT shall evaluate initial and sustained Primary Frequency Response using an expected performance Governor droop of 5.78% for combined-cycle Resources.

5. Intermittent Renewable Resources (IRRs) located behind one Point of Interconnection (POI), metered by one ERCOT-Polled Settlement (EPS) Meter, and operated as an integrated Facility may combine IRRs for the purposes of this test.

***Definitions***

Generation Resource, ESR, or CLR Base Load = MDRR (this value is not reduced for temporary output limitations of the Generation Resource, ESR, or CLR due to auxiliary equipment outages, weather conditions, or fuel limitations, it is the “nameplate” rating of the Generation Resource, ESR, or CLR). For the IRR, the Base Load for purposes of this test shall be their MDRR. The IRR shall use only a FME in which the IRR’s HSL is greater than 50% of the IRR’s total design output capability.

HISTORICAL GENERATION RESOURCE, Energy Storage Resource, OR CONTROLLABLE LOAD RESOURCE **FREQUENCY RESPONSE TEST FORM**

***General Information***

Unit Code (16 characters): Location (County):

Unit Name: Date of FME:

QSE: Resource Entity:

***Historical Results***

|  |  |
| --- | --- |
| ***Evaluation Point*** | ***Frequency*** |
| ***Time (sec) of FME (t(0))*** |  |
| ***Pre-Perturbation Average Frequency (t(-2) to t(-16))*** |  |
| ***Post-Perturbation Average Frequency (t(20) to t(52))*** |  |

|  |  |  |
| --- | --- | --- |
| **1** | **Pre-Perturbation Average MW [T(-2 ) to T(-16)]** |  |
| **2** | **Post-Perturbation Average MW [T(+20 to T(+52)]** |  |
| **3** | **Expected Initial Primary Frequency Response (MW)** |  |
| **4** | **Expected Sustained Primary Frequency Response (MW)** |  |
| **5** | **Adjusted Actual Initial Primary Frequency Response (MW)** |  |
| **6** | **Adjusted Actual Sustained Primary Frequency Response (MW)** |  |
| **7** | **Initial Response P.U. Performance** |  |
| **8** | **Sustained Response P.U. Performance** |  |

***Comments:*** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

***Submittal***

Resource Entity Representative: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

QSE Representative: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date submitted to ERCOT Representative:

Intermittent renewable resource (IRR) Frequency Response Test Procedure

***Description of the Test***

1. The frequency response function of the Intermittent Renewable Resource (IRR) is tested On-Line at a Load level that allows the IRRs to increase or decrease Load without reaching low operating limits or high operating limits.

2. The test is performed by adding a frequency offset signal that exceeds the Governor Dead-Band value to the measured frequency signal. This should create immediate step change in the measured frequency signal.

3. The test starts at time t0 when the frequency Dead-Band is exceeded.

4. The MW output signal should be recorded at least every two seconds.

5. The duration of the test is 100 seconds. After 100 seconds, the offset signal should be removed and the IRR should return to pretest power output.

6. The test should be conducted both with positive and negative frequency offsets.

7. The test is considered successful after the signal becomes active if at least 70% of the calculated MW contribution is delivered within 16 seconds and the response is maintained for an additional 30 seconds.

8. Governor droop and Governor Dead-Band settings shall be set in accordance with Section 2.2.7, Turbine Speed Governors.

9. IRRs located behind one POI, metered by one ERCOT-Polled Settlement (EPS) Meter, and operated as an integrated Facility may combine IRRs for the purposes of this test.

***Definitions***

**IRR Base Load =** MDRR. The test shall be performed at an output level which is greater than 50% of IRR’s total design output capability.

**Gain MW for 0.1Hz** consistent with a selected droop percentage =



Where:

*P* = IRR telemetered HSL (MW)

*Droop* = droop (%)

**Frequency Offset** = +0.2 Hz and -0.2 Hz, outside Governor Dead-Band

**Test frequency** = Measured Frequency + Frequency Offset

**MW Contribution** = Gain MW to 0.1 Hz \* 10 \* Frequency Offset

**Calculated droop** = - 

Where:

*P* = IRR telemetered HSL (MW)

*ΔHz* = Change in frequency (Hz), taking into account Governor Dead-Band

*ΔMW* = Change in power output (MW)

***Example***

IRR telemetered HSL = 150 MW

Droop = 0.05 or 5% (use 0.05 for calculation)

Governor Dead-Band = 0.017 Hz

Gain MW for 0.1 Hz =  = +/- 5.03 MW/0.1 Hz

∆MW Contribution = 5.03 \* 10\* +/-0.2 = +/-10.06 MW

Expected under-frequency response: +10.06 MW in 16 sec. for -0.2 Hz offset

Expected over-frequency response: -10.06 MW in 16 sec. for +0.2 Hz offset

Minimum accepted under-frequency response: +7.04 MW in 16 sec. for -0.2 Hz offset

Minimum accepted over-frequency response: -7.04 MW in 16 sec. for +0.2 Hz offset

Calculated droop for 8MW increase in power output in 16 sec. for -0.2 Hz offset:

Calculated percent droop = - \*100 = 6.25%

**Intermittent renewable resource (IRR) FREQUENCY RESPONSE TEST FORM**

***General Information***

Unit Code (16 characters): Location (County):

Unit Name: Date of Test:

QSE: Resource Entity:

***Test Results***

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | **Test with +0.2 Hz** | **Test with -0.2 Hz** |
| **1** | **IRR Base Load** |  |  |
| **2** | **GAIN MW to 0.1Hz** |  |  |
| **3** | **Calculated Minimum**  **MW Contribution** |  |  |
| **4** | **MW at test start (t0)** |  |  |
| **5** | **MW at t0 + 16 sec** |  |  |
| **6** | **MW Contribution**  **at t0 + 16 sec** |  |  |
| **7** | **MW at t0 + 46 sec** |  |  |
| **8** | **Calculated droop** |  |  |
| **9** | **CONCLUSION**  **(PASSED/FAILED)** |  |  |

***Comments***: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

***Submittal***

Resource Entity Representative: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

QSE Representative: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date submitted to ERCOT Control Area Authority Rep.: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Controllable load resource Frequency Response Test Procedure

***Description of the Test***

1. The frequency response function of the Controllable Load Resource (CLR) is tested On-Line at a Load level that allows CLRs to increase or decrease Load without reaching Low Power Consumption (LPC) or Maximum Power Consumption (MPC).

2. The test is performed by adding a frequency offset signal that exceeds the Governor Dead-Band value to the measured frequency signal. This should create an immediate step change in the measured frequency signal.

3. The test starts at time t0 when the frequency Dead-Band is exceeded.

4. The MW output signal should be recorded at least every two seconds.

5. The duration of the test is 100 seconds. After 100 seconds, the offset signal should be removed and the CLR should return to pretest power output.

6. The test should be conducted both with positive and negative frequency offsets.

7. The test is considered successful after the signal becomes active if at least 70% of the calculated MW contribution is delivered within 16 seconds and the response is maintained for an additional 30 seconds.

8. Governor droop and Governor Dead-Band settings shall be set in accordance with Section 2.2.7, Turbine Speed Governors.

***Definitions***

**Controllable Load Resource Base Load =** MDRR. The test shall be performed at an output level that allows the CLR to increase or decrease Load without reaching LPC or MPC.

**Gain MW for 0.1Hz** consistent with a selected droop percentage =



Where:

*P* = CLR telemetered MPC (MW)

*Droop* = droop (%)

**Frequency Offset** = +0.2 Hz and -0.2 Hz, outside Governor Dead-Band

**Test frequency** = Measured Frequency + Frequency Offset

**MW Contribution** = Gain MW to 0.1 Hz \* 10 \* Frequency Offset

**Calculated droop** = - 

Where:

*P* = CLR telemetered MPC

*ΔHz* = Change in frequency (Hz), taking into account Governor Dead-Band

*ΔMW* = Change in power output (MW)

***Example***

CLR telemetered MPC = 150 MW

Droop = 5%

Governor Dead-Band = 0.036 Hz

Gain MW to 0.1 Hz =  = +/- 5.06 MW/0.1 Hz

∆MW Contribution = 5 \* 10\* +/-0.2 = +/-10.12 MW

Expected under-frequency response: -10.12 MW in 16 sec. for -0.2 Hz offset

Expected over-frequency response: +10.12 MW in 16 sec. for +0.2 Hz offset

Minimum accepted under-frequency response: -7.08 MW in 16 sec. for -0.2 Hz offset

Minimum accepted over-frequency response: +7.08 MW in 16 sec. for +0.2 Hz offset

Note: The negative sign in expected under-frequency response and minimum accepted under-frequency response denotes the required reduction in power consumption. Similarly the positive sign in expected over-frequency response and minimum accepted over-frequency response denotes the required increase in power consumption.

Calculated droop for 8 MW increase in power output in 16 sec. for -0.2 Hz offset:

Calculated percent droop = - = 6.25%

**Controllable load resource FREQUENCY RESPONSE TEST FORM**

***General Information***

Unit Code (16 characters): Location (County):

Unit Name: Date of Test:

QSE: Resource Entity:

***Test Results***

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | **Test with +0.2 Hz** | **Test with -0.2 Hz** |
| **1** | **CLR Base Load** |  |  |
| **2** | **GAIN MW to 0.1 Hz** |  |  |
| **3** | **Calculated Minimum**  **MW Contribution** |  |  |
| **4** | **MW at test start (t0)** |  |  |
| **5** | **MW at t0 + 16 sec** |  |  |
| **6** | **MW Contribution**  **at t0 + 16 sec** |  |  |
| **7** | **MW at t0 + 46 sec** |  |  |
| **8** | **Calculated droop** |  |  |
| **9** | **CONCLUSION**  **(PASSED/FAILED)** |  |  |

***Comments***: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

***Submittal***

Resource Entity Representative: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

QSE Representative: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date submitted to ERCOT Control Area Authority Rep.:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Westinghouse recommends using only this test. [↑](#footnote-ref-1)
2. Westinghouse recommends using only this test. [↑](#footnote-ref-2)