

# Dynamic Moderation Response Balancing Service

Test Guidance for Providers

Version 1 – 11 March 2022



# Foreword

This document aims to provide guidance to Dynamic Moderation providers to National Grid Electricity System Operator (NGESO). This document covers the testing requirements for pre-qualification assessment and re-proving of this service. The tests outlined in the document are to verify that the requirements of the service specified in contract documents can be met. For any further enquires or questions, contact your Account Manager or:

E-mail [commercial.operation@nationalgrideso.com](mailto:commercial.operation@nationalgrideso.com)

Telephone +44 (0) 1926 654611

The test results will be assessed by an Independent Technical Expert (ITE). (See Appendix A)

To complete the pre-qualification requirement, the following information must be submitted to NGESO:

- The test data, in the format outlined in Appendix C
- A report from the ITE, in the format outlined in Appendix E
- A CV, setting out the qualifications and experience of the ITE

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# Test Requirements

## Service description

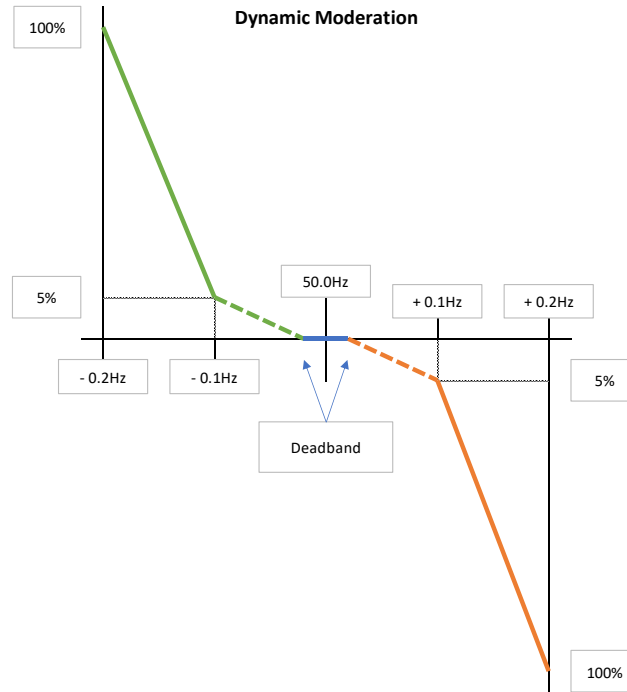
Dynamic Moderation (DM) rapidly delivers with the aim of assisting the ESO to keep frequency within operational limits. Providers of DM will help manage imbalances between demand and generation by responding quickly when frequency moves towards the edge of the operational range.

Table 1 - Dynamic Moderation Service Specification

| Service specification             | Details  |
|-----------------------------------|--|
| Speed of response                 | 1 second   |
| Pre/post fault                    | Pre-fault  |
| Delivery range                    | $\pm 0.1\text{Hz}$ to $\pm 0.2\text{Hz}$                               |
| Deadband (delivery %)             | $\pm 0.015\text{Hz}$ (0%)  |
| Initial linear range (delivery %) | $\pm 0.015\text{Hz}$ to $\pm 0.1\text{Hz}$ (5% at $\pm 0.1\text{Hz}$ ) |
| Knee point                        | $\pm 0.1\text{Hz}$   |
| Second linear range (delivery %)  | $\pm 0.1\text{Hz}$ to $\pm 0.2\text{Hz}$ (100% at $\pm 0.2\text{Hz}$ ) |
| Full delivery point               | $\pm 0.2\text{Hz}$   |
| Max ramp start                    | 0.5 second   |
| Time to full delivery             | 1 second   |

See Dynamic Moderation Service Terms and supporting documentation for more details:  
<https://www.nationalgrideso.com/industry-information/balancing-services/Frequency-Response-Services/Dynamic-Moderation>

Figure 1 – Dynamic Moderation Delivery Requirements



## Dynamic Moderation Test Requirements

The Dynamic Moderation tests assess the capability of the service provider to deliver dynamic response in accordance with the balancing service contract.

Tests 1, 2 and 3 assess response against injected frequency profiles. Test 4 assesses response whilst connected to live system frequency. The frequency profile can be injected either at site or remotely. The minimum sample rate for all tests is 20Hz. See Appendix B for information on test signals.

Please note that all example graphs in this Testing Guidance are for illustrative purposes only.

## Aggregation/Test Approach

These tests are designed to meet the NGENSO requirement for service validation as well as being equally suitable for all types of DM units (both single-site or multi-site units) and technology types (generation, storage, demand or a combination of same). The tests also consider how providers adding to and evolving their aggregated portfolios over time can have additional assets validated.

The dynamic tests can assess the capability of

- A single asset
- A group of assets
- Asset/s to be added to an existing aggregated facility

## Test 1 – Step Test

The purpose of Test 1 is to assess the unit’s ability to deliver the required response at discreet frequency deviations.

The frequency injections to be used are shown in **Figure 2** and below.

- Each step is sustained for 180 seconds to verify the response.
- The frequency will then be returned to 50Hz for a minimum of 30 seconds, or until the output is stable, before the next injection is applied.
- The minimum sample rate for Test 1 is 20Hz.

## Pass Criteria for Test 1

- For Tests 1.1 and 1.2, the unit should not provide any response within the deadband. Where there are any non-zero values here these need to be explained by the ITE in the test report using the comments field.
- For tests 1.3 and 1.4 all that is required is a noticeable change in power in the correct direction.
- For Tests 1.5 to 1.8 the active power response within each 3 minute timescale should fall within tolerances shown in **Table 3** and shown graphically in **Figure 3**.

(Performance monitoring criteria used to calculate tolerance bands)

- A response following a change of frequency should occur before 0.5 second.
- Delivery of active power due to a change in frequency should be achieved in the required timescale.
- The Unit should monotonically progress to its required response.

Figure 2 - Test 1

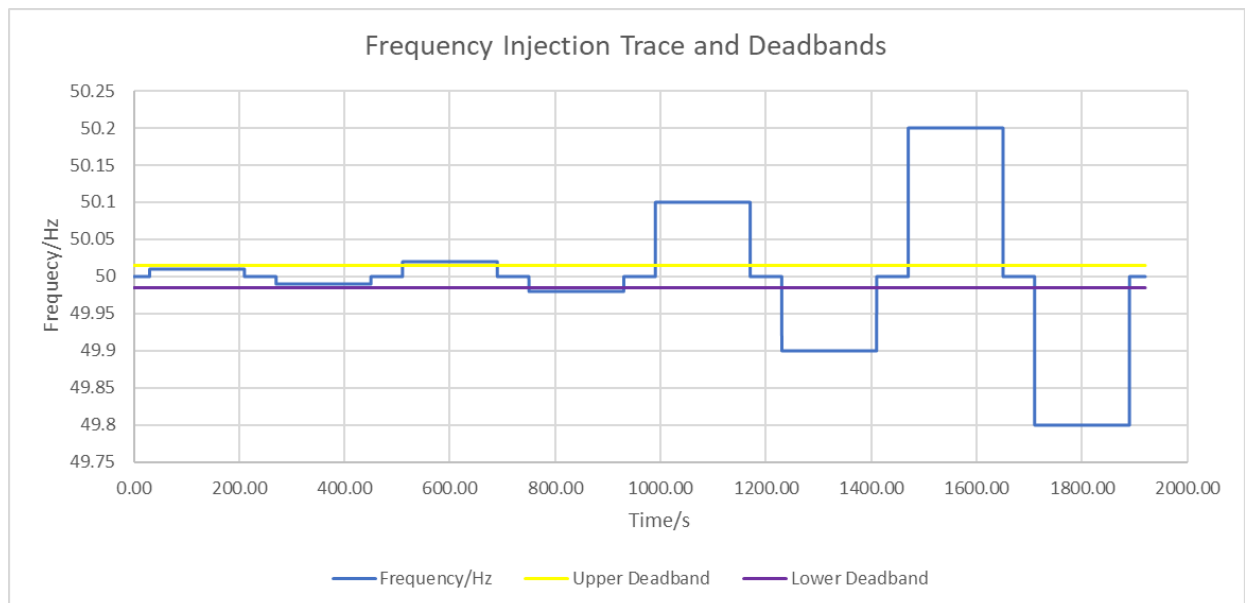


Table 2 - Test 1 Frequency Injection Profile corresponding with times

| Test | Parameter     | Values  |    |       |       |     |     |
|------|---------------|---------|----|-------|-------|-----|-----|
|      |               | Time /s | 0  | 30    | 30    | 210 | 210 |
| 1.1  | Frequency /Hz | 50      | 50 | 50.01 | 50.01 | 50  | 50  |
| 1.2  | Frequency /Hz | 50      | 50 | 49.99 | 49.99 | 50  | 50  |
| 1.3  | Frequency /Hz | 50      | 50 | 50.02 | 50.02 | 50  | 50  |
| 1.4  | Frequency /Hz | 50      | 50 | 49.98 | 49.98 | 50  | 50  |
| 1.5  | Frequency /Hz | 50      | 50 | 50.1  | 50.1  | 50  | 50  |
| 1.6  | Frequency /Hz | 50      | 50 | 49.9  | 49.9  | 50  | 50  |
| 1.7  | Frequency /Hz | 50      | 50 | 50.2  | 50.2  | 50  | 50  |
| 1.8  | Frequency /Hz | 50      | 50 | 49.8  | 49.8  | 50  | 50  |

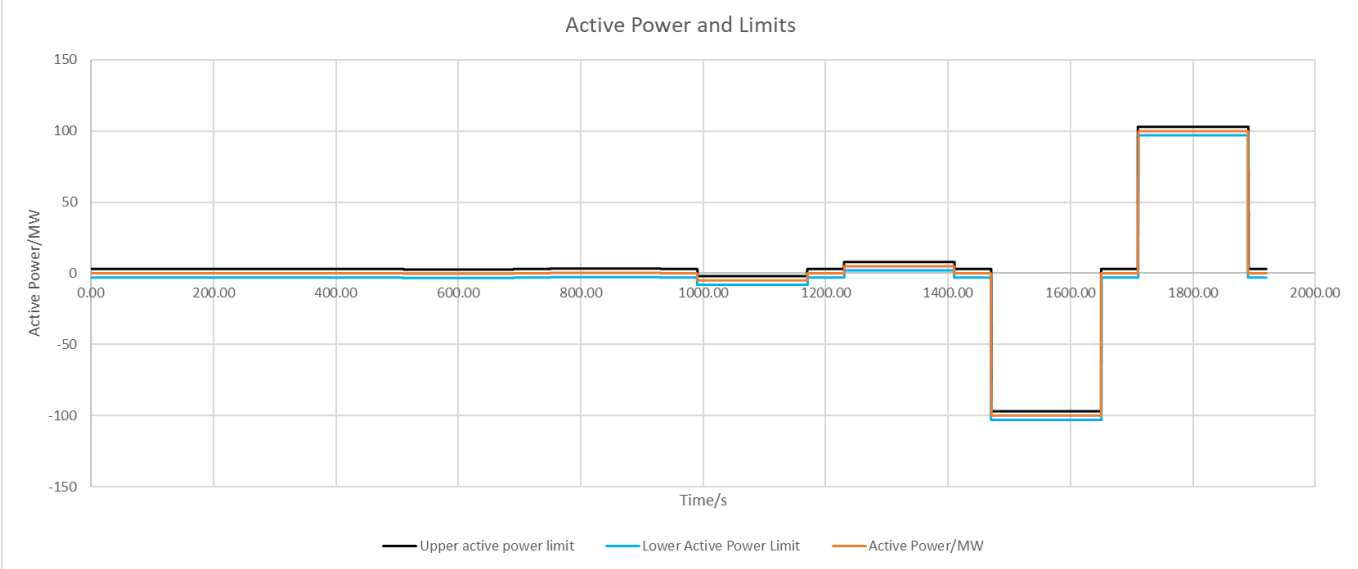
Table 3 - Test 1 Frequency Injection and expected response value.

| Test Number | Frequency Step | Expected Response | Allowable Power Tolerance (% of Maximum Contracted) |
|-------------|----------------|-------------------|---|
| 1.1         | 50.01          | 0%                | n/a   |
| 1.2         | 49.99          | 0%                | n/a   |
| 1.3         | 50.02          | 0.135%            | *   |
| 1.4         | 49.98          | 0.135%            | *   |
| 1.5         | 50.1           | 5%                | ± 3%  |
| 1.6         | 49.9           | 5%                | ± 3%  |
| 1.7         | 50.2           | 100%              | ± 3%  |
| 1.8         | 49.8           | 100%              | ± 3%  |

For values with an asterisk (\*) a noticeable change in power in the correct direction is all that is required.



Figure 3 - Graphical representation of tolerance bands for the expected response at different frequencies – sample data



## Test 2 – Frequency Sweep Test

Test 2 assesses the unit’s performance against a varying frequency over the entire performance envelope.

- The frequency injections to be used are shown in **Figure 4** and **Figure 5** and **Table 4** below.
- The minimum sample rate for Tests 2.1 and 2.2 is 20Hz.

### Pass Criteria for Tests 2.1 and 2.2

- For Test 2.1 and 2.2, active power response is within the tolerances in **Figure 6/Figure 7** and **Table 5**. (Performance monitoring criteria used to calculate tolerance bands)

Figure 4 - Test 2.1

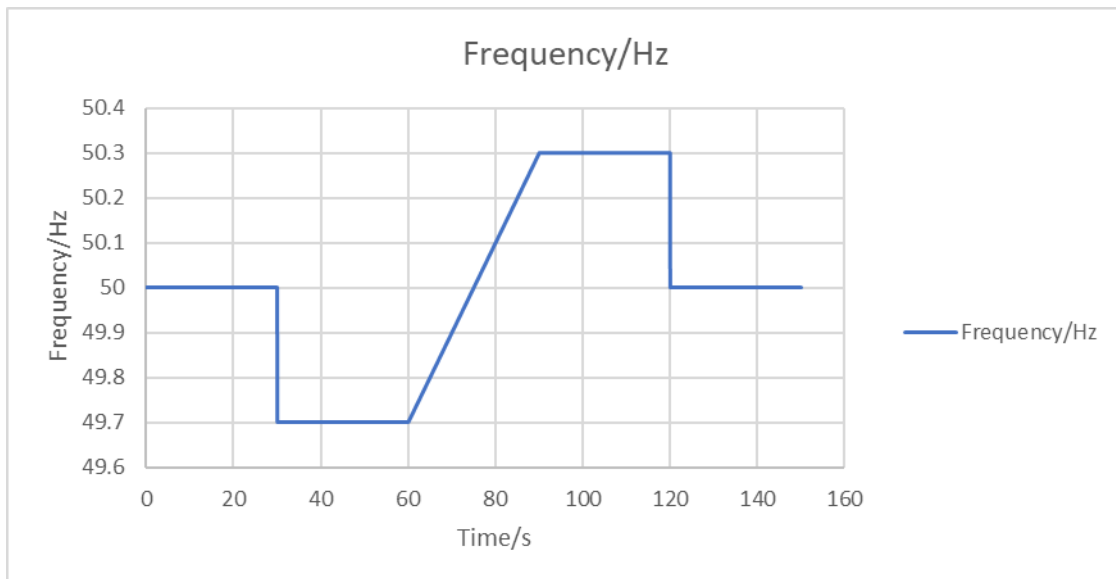


Figure 5 - Test 2.2

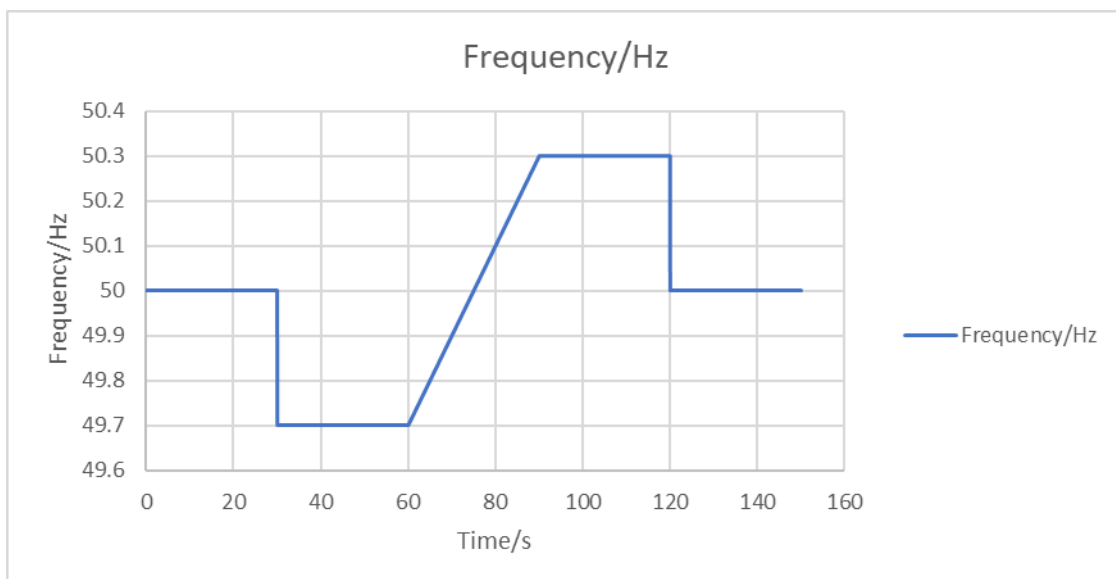


Table 4 - Test 2 Frequency Injection Profiles

| Time /s | Injected Frequency /Hz |          |
|---------|------------------------|----------|
|         | Test 2.1               | Test 2.2 |
| 0       | 50                     | 50       |
| 30      | 50                     | 50       |
| 30      | 49.7                   | 50.3     |
| 60      | 49.7                   | 50.3     |
| 75      | 50                     | 50       |
| 90      | 50.3                   | 49.7     |
| 120     | 50.3                   | 49.7     |
| 120     | 50                     | 50       |
| 150     | 50                     | 50       |

Figure 6 - Test 2.1 Tolerance

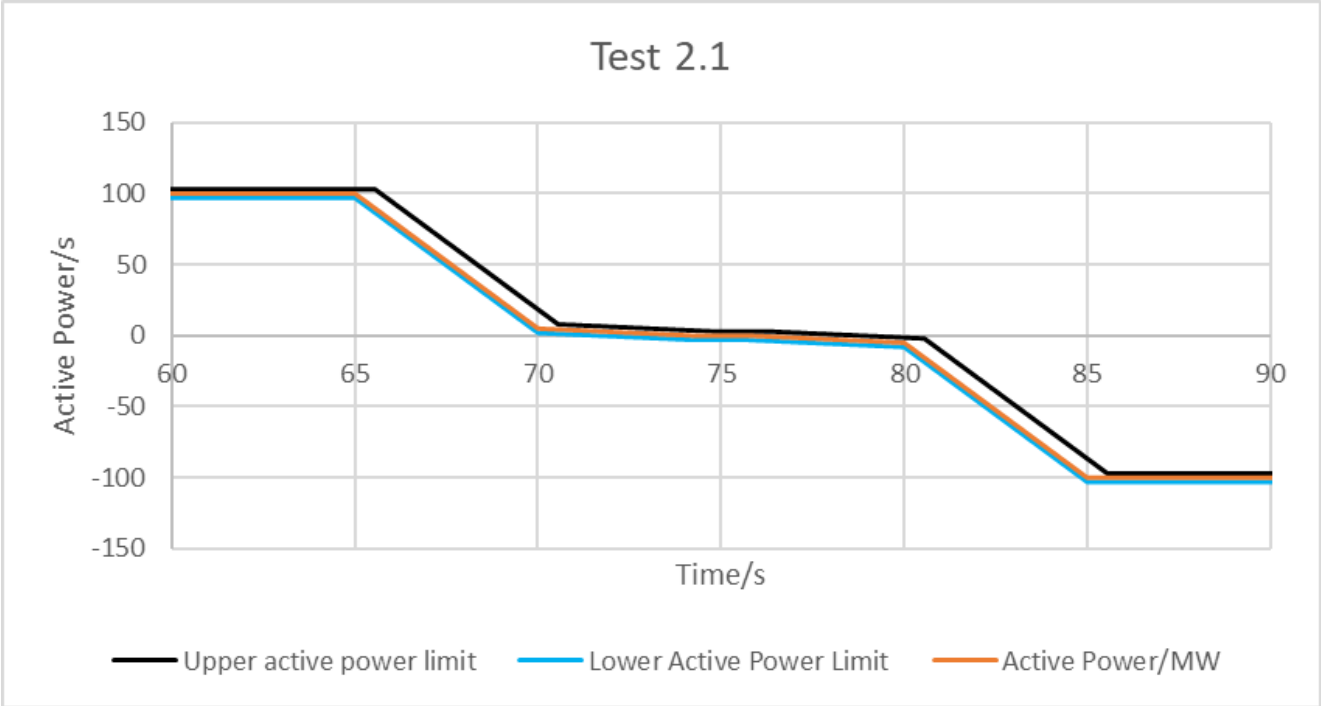


Figure 7 - Test 2.2 Tolerance

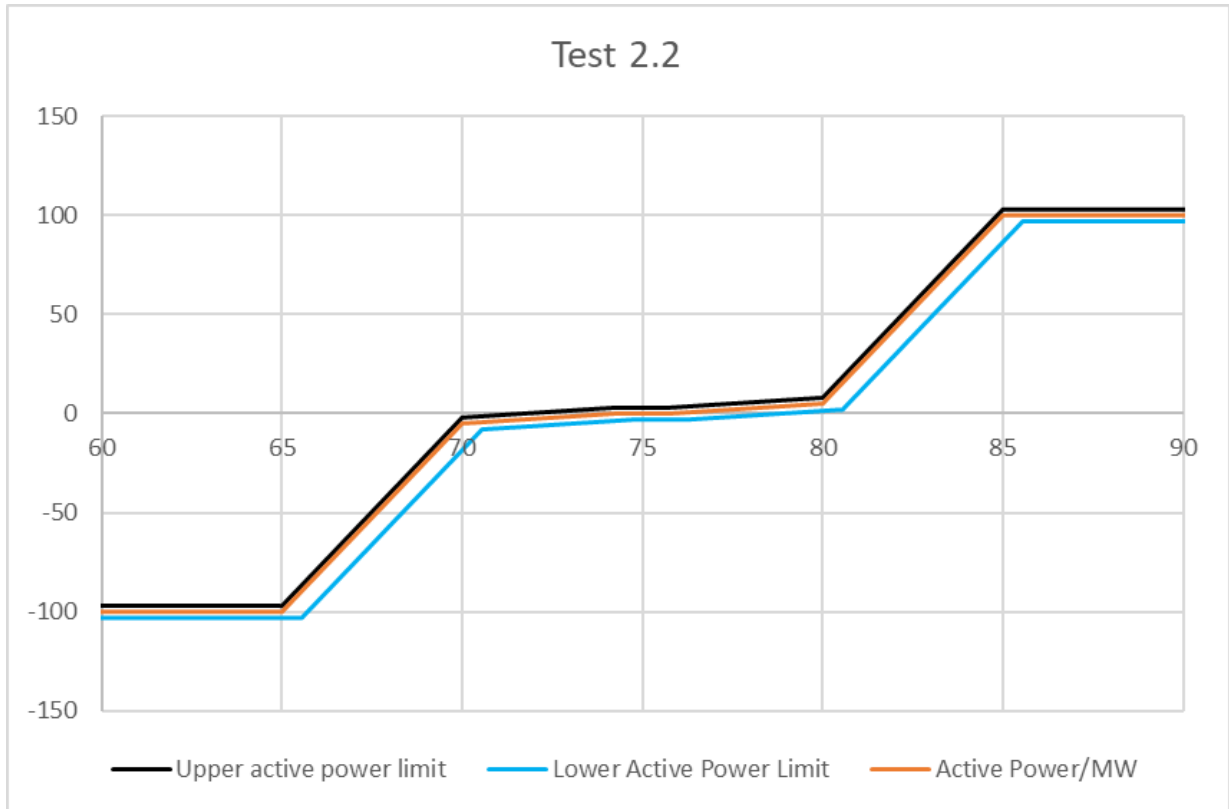


Table 5 - Test 2.1 and 2.2 Sweep Test tolerances (Without time delay to reach required delivery included)

| Test 2.1 and Test 2.2 |   |                                     |
|-----------------------|---|-------------------------------------|
| Frequency (Hz)        | Expected Percentage Active Power Response (%) | Tolerance (% of Maximum Contracted) |
| 50.3                  | 100   | ±3%                                 |
| 50.2                  | 100   | ± 3%                                |
| 50.1                  | 5   | ± 3%                                |
| 50.0                  | 0   | 0%                                  |
| 49.9                  | 5   | ± 3%                                |
| 49.8                  | 100   | ± 3%                                |
| 49.7                  | 100   | ± 3%                                |

### Test 3 Duration Test

Test 3 assesses the unit’s ability to sustain full response for 30 minutes.

- Operation will be tested at  $\pm 100\%$  of capability to ensure the system is compliant.
- This is carried out by a frequency step of  $\pm 0.3\text{Hz}$  onto the system for 30 minutes.
- The frequency injection profiles are shown in **Figure 8** and **Figure 9** and **Table 6** and **Table 7** below
- Please note that providers can reuse existing duration tests for an asset, providing that they are for the same duration or longer and have the same MW value

### Pass criteria for test 3:

- The standard deviation of load error at steady state over a 30-minute period must not exceed 2.5% of the maximum contracted active power.
- Sustain response for 30 minutes.

Figure 8 Test 3.1 Injection Profile

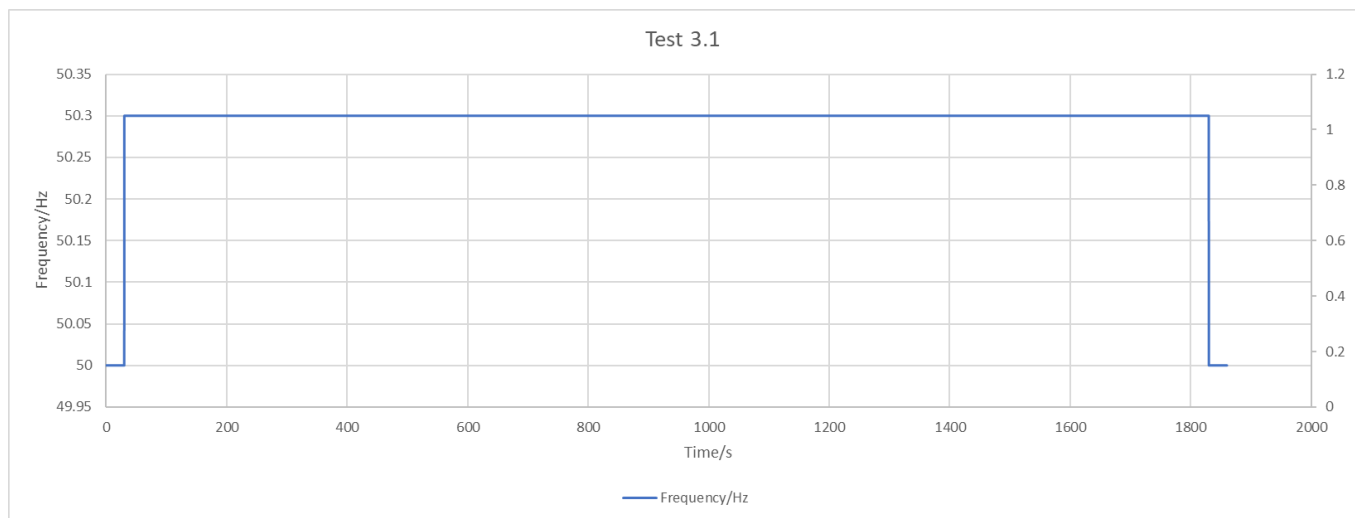


Figure 9 Test 3.2 Injection Profile

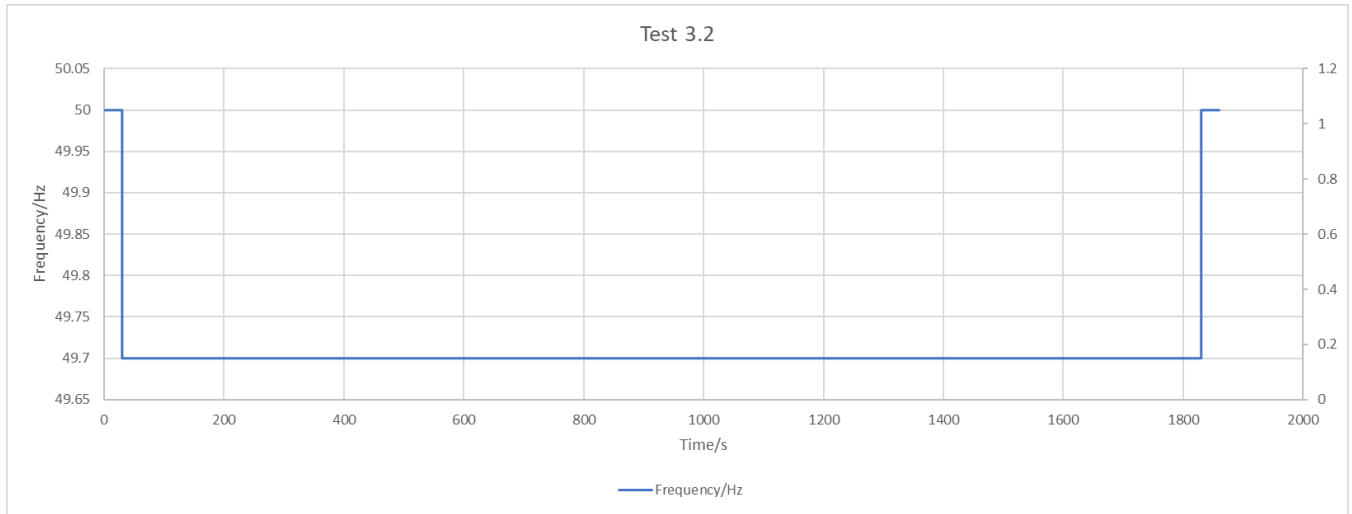


Table 6: Test 3.1 Frequency Injection Table Corresponding with times

| Test 3.1 Frequency injection table |    |    |      |      |      |      |
|------------------------------------|----|----|------|------|------|------|
| Time /s                            | 0  | 30 | 30   | 1830 | 1830 | 1860 |
| Frequency /Hz                      | 50 | 50 | 50.3 | 50.3 | 50   | 50   |

Table 7: Test 3.2 Frequency Injection Table Corresponding with times

| Test 3.2 Frequency injection table |    |    |      |      |      |      |
|------------------------------------|----|----|------|------|------|------|
| Time /s                            | 0  | 30 | 30   | 1830 | 1830 | 1860 |
| Frequency /Hz                      | 50 | 50 | 49.7 | 49.7 | 50   | 50   |

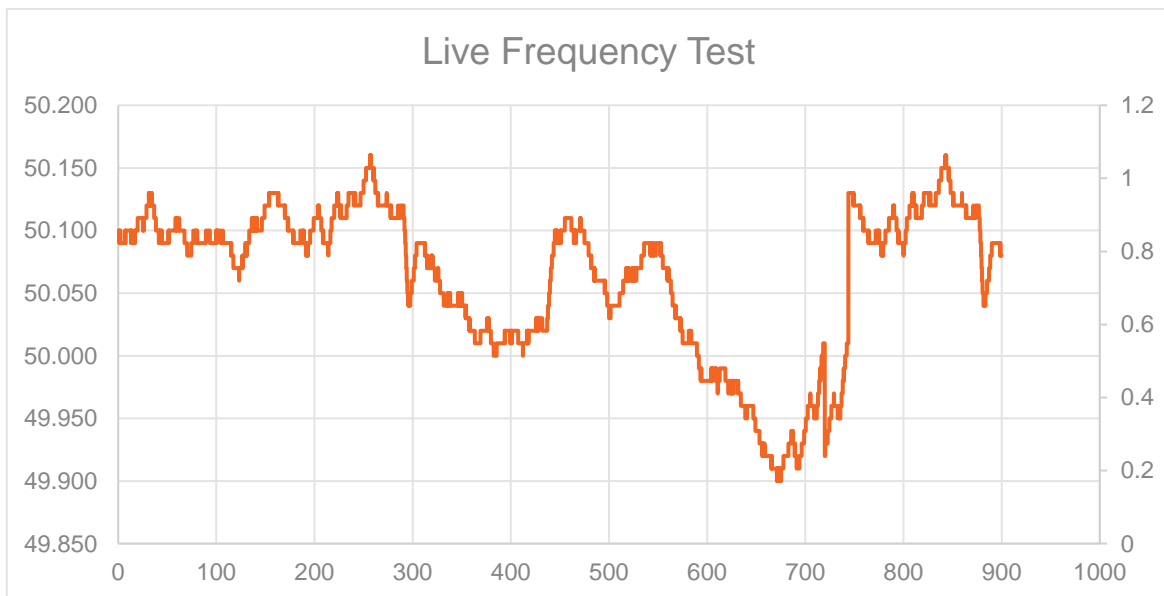
## Test 4 – Live System Frequency Response Test

Test 4 assesses the unit’s response to system frequency in a live environment. The minimum sample rate for this test is 20Hz and duration is 30 minutes where system frequency and active power response will be recorded. As part of test 4, you are required to provide evidence that the protection settings are in line with the Grid Code ( $\pm$  of 5% of 50Hz).

### Pass Criteria for Test 4

- Provide an active power response consistent with the contracted performance within timescales.
- Provide evidence protection setting comply with Grid Code.

Figure 10 - Sample System Frequency





# Appendices



## Appendix A - Independent Technical Expert (ITE)

The Dynamic Moderation test results will be assessed by an **Independent Technical Expert (ITE)** who will prepare a **Test Certificate**. The following definitions shall apply:

**Group** means, for any person, another person who is the direct or indirect **Holding Company** of that person and any **Subsidiary** of that **Holding Company**.

**Holding Company** means, in relation to a company, any other company in respect of which it is a **Subsidiary**.

**Independent Technical Expert** means an experienced technical expert with expertise in the operation of demand side response (DSR) or generating units or electricity Interconnectors (as the case may be), **Independent** of the prospective response provider, engaged by the prospective response provider at its expense to carry out a technical assessment and prepare a **Test Certificate**.

**Independent** means, for any technical expert and the applicable prospective response provider, that the technical expert is:

- (a) not in the same **Group** as the prospective response provider; and
- (b) neither engaged on terms, nor party to any other arrangements, which could allow the prospective response provider or any member of its **Group** to exercise undue influence on any assessment of the **Test Certificate** prepared by that technical expert or otherwise compromise the objectivity of any such assessment and test certificate to the **Required Technical Standard**.

**Required Technical Standard** means, with respect to any assessment and **Test Certificate** prepared by an **Independent Technical Expert** that:

- (a) to the best of the **Independent Technical Expert**'s knowledge and belief all information provided in it is accurate, complete and not misleading; and
- (b) any opinions or forecasts in the assessment have been conservatively prepared on assumptions which it considers to be fair and reasonable.

**Subsidiary** means a subsidiary within the meaning of section 1159 of the Companies Act 2006 (but relation to an Interconnector, or shareholder in such provider, subsection (1)(a) of that section shall apply as if a "majority of the voting rights" included 50% only of those rights)

**Test Certificate** means a certificate in the form set out in Appendix E (dynamic) prepared by an **Independent Technical Expert**.

# Appendix B – Test Signals

The limits of error and minimum sample rates for testing are shown below in **Table 8**. All success criteria are subject to the stated limit of error/accuracy threshold.

**Table 8 - Limits of error and minimum sample rates for Dynamic Moderation Testing**

|                                | Limit of error/<br>Accuracy threshold | Minimum Sample rate<br>Test 1 | Minimum Sample rate<br>Tests 2 and 3 |
|--------------------------------|---------------------------------------|-------------------------------|--------------------------------------|
| Injection Frequency (Hz)       | ±0.01 Hz                              | 20Hz                          | 20Hz                                 |
| Active Power (MW)              | Please see pass criteria              | 20Hz                          | 20Hz                                 |
|                                | Limit of error/<br>Accuracy threshold | Minimum Sample rate<br>Test 4 |                                      |
| Measured System Frequency (Hz) | ±0.001 Hz                             | 20Hz                          |                                      |
| Active Power (MW)              | Please see pass criteria              | 20Hz                          |                                      |

Simulations / simulated tests are not permitted. Each test submitted must record real time data from the plant and sites under test: The test data submitted must come from the specific site to be contracted; substituted data will not be accepted. Test results must not be changed before submission for analysis.

### Test Signals

In ALL cases, the data should record ALL required signals for at least 30 seconds BEFORE the application of the frequency injection signal and for at least 30 seconds AFTER the completion of the test.

For ALL services, the data for the following signals will need to be provided

- a) Time
- b) Active Power
- c) System Frequency or Injected frequency as appropriate
- d) Any other relevant signals that may affect the success criteria such as Relay Logic for non-dynamic.

# Appendix C - Dynamic Moderation Test Data Format

Figure 11 - Sample Dynamic Moderation Test Data Format

|          |                      |                  |
|----------|----------------------|------------------|
| Provider | Company Name         |                  |
| Date     | xx-xx-xxxx           |                  |
| Test     | 1                    |                  |
| Service  | Dymanic Moderation   |                  |
| Location | AA                   |                  |
| Site     | AA                   |                  |
|          |                      |                  |
| Time/s   | Injected Frequency/s | Measred Power/MW |
| 0        | 50.00                | 0.00             |
| 0.05     | 50.00                | 0.00             |
| 0.1      | 50.00                | 0.00             |
| 0.15     | 50.00                | 0.00             |
| 0.2      | 50.00                | 0.00             |
| 0.25     | 50.30                | 5.00             |
| 0.3      | 50.30                | 5.00             |
| 0.35     | 50.30                | 5.00             |
| 0.4      | 50.30                | 5.00             |
| 0.45     | 50.30                | 5.00             |
| 0.5      | 50.30                | 5.00             |
| 0.55     | 50.30                | 5.00             |
| 0.6      | 50.00                | 0.00             |
| 0.65     | 50.00                | 0.00             |
| 0.7      | 50.00                | 0.00             |
| 0.75     | 50.00                | 0.00             |
| 0.8      | 50.00                | 0.00             |

- Frequency Injection should be to 2 decimal places
- Measured Power should be to 3 decimal places
- Measured frequency for test 4 should be to 3 decimal places

Further columns can be added to include data for several sites if required.

For Test 4 replace 'Injected Frequency' with 'Measured Frequency'.

## Appendix D – Dynamic Moderation Test Assessment

Excel Analysis Tool published with User Guide.

See Test certificate template in Appendix E for further guidance.

# Appendix E – Dynamic Moderation Test Certificate Template

Please use this Test Certificate format and submit to NGENSO, along with the test data and CV of the ITE employed by the prospective response provider.

## Prospective Response Provider Company Details

Contracted company name

Primary contact name

Contact number/s

Email address

## Contract Details

Contract ID

Service type

Asset type, e.g. battery

Unit make up, e.g. single or aggregated

*Describe here what is included in this test e.g. Single asset, group of assets, asset/s being assessed within an existing Unit.*

Aggregation methodology (if appropriate)

Unit location / ID

**Do any assets associated with this report have a condition in their DNO connection agreement whereby they are signed up to an Active Network management (ANM) Scheme / Flexibility Connection?**

**If yes, please ensure contracted party speaks to their ESO account manager.**

Contract signed date

Service start date

Test date

## Dynamic Service Details *(example here is for a 5MW Unit)*

Deadband ±0.015Hz

Response / MW 5

## Test Results

*Further relevant test description/commentary here*

| Test                       | Pass Criteria  | Pass/Fail | Comment   |
|----------------------------|--|-----------|---|
| 1.1, 1.2                   | No delivery within deadband. Where there are any non-zero values here these need to be explained by the ITE in the test report using the comments field. |           |   |
| 1.3,1.4                    | For Test 1.3 and 1.4 a noticeable change in active power in the correct direction is all that is required.   |           |   |
| 1.5-1.8                    | Active power response within each 3 minute timescale remains within tolerances.  | Pass      | Note result here (See Figure ...)   |
| 1.5-1.8                    | A response following a change of frequency should occur within 0.5 second.   |           |   |
| 1.5-1.8                    | Delivery of active power due to a change in frequency is achieved in the required timescale  | Pass      |   |
| 1.5-1.8                    | The Unit should monotonically progress to its required response  | Pass      |   |
| 2.1<br>2.2                 | Active power response is within the allowed tolerances.  | Pass      | Show in figure below with tolerance bands overlaid.                                       |
| 3                          | Response is sustained for 30 minutes   | Pass      | Refer to figures  |
| 3                          | The standard deviation of load error at steady state over a 1800 second period must not exceed 2.5% of the maximum contracted active power.              | Pass      | Standard deviation is assessed from 1 second until 1800 seconds after the frequency step. |
| 4                          | Provide an active power response consistent with the contracted performance timescales.  |           | Figure should show the active power following frequency as expected.                      |
| <b>Overall Test Result</b> |  |           |   |

## Test Result Graphs

Plot frequency injection and active power response vs time for each test.

Figure 1 – Test 1 Active Power Response

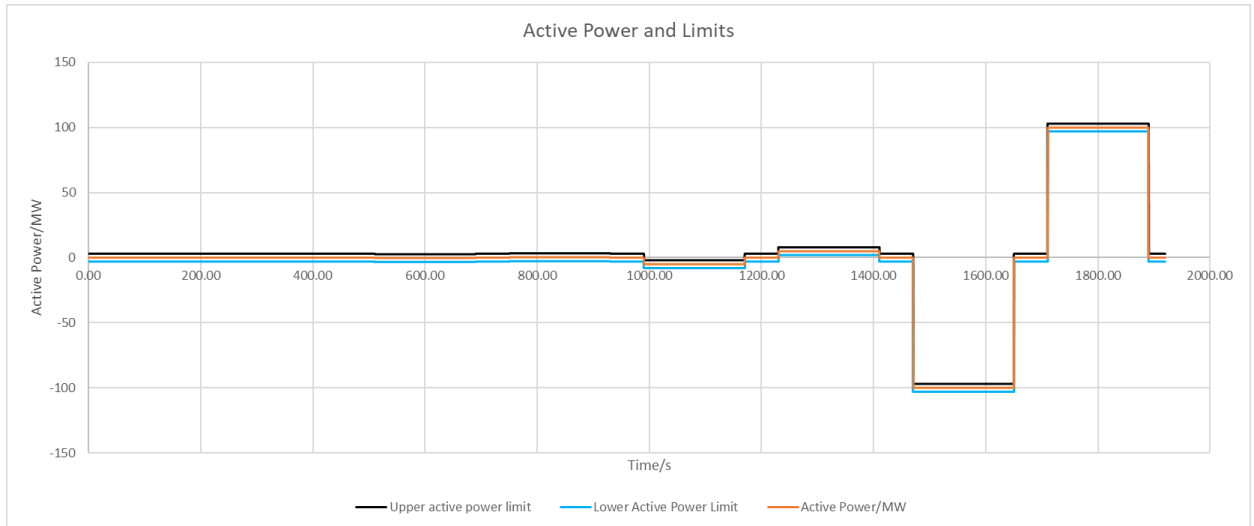


Figure 2 – Test 1.1

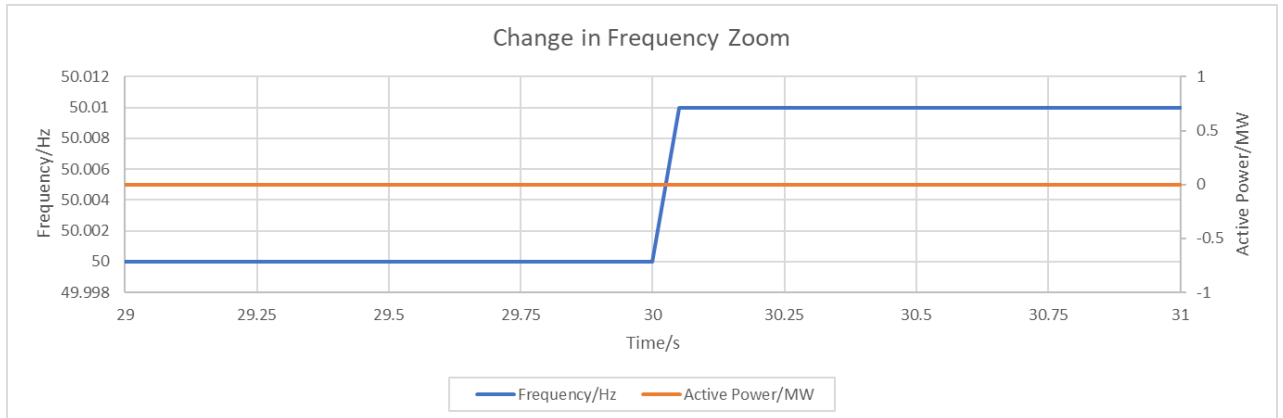


Figure 3 – Test 1.3

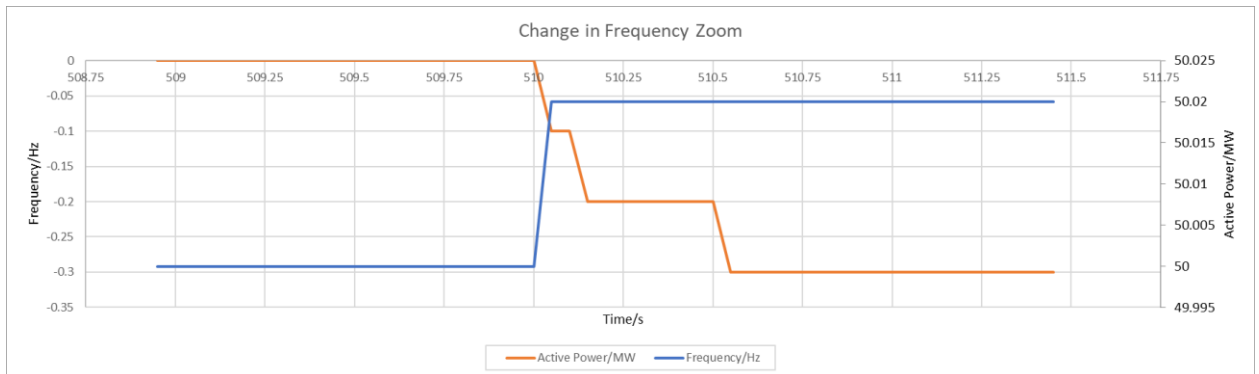


Figure 4 – Test 1.6

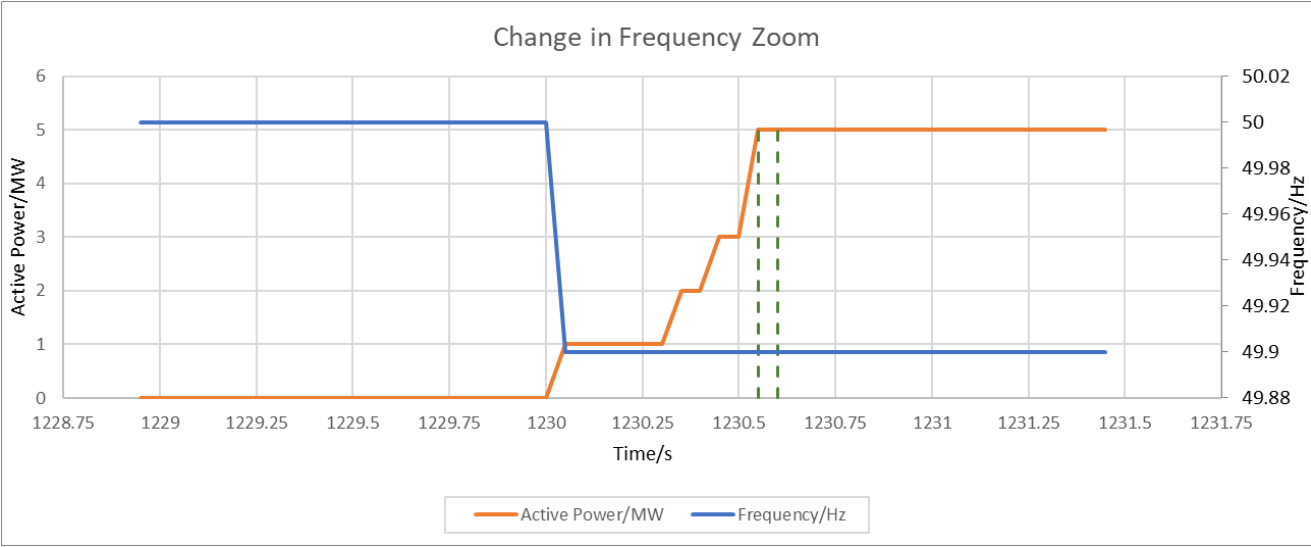


Figure 5 – Test 1.7

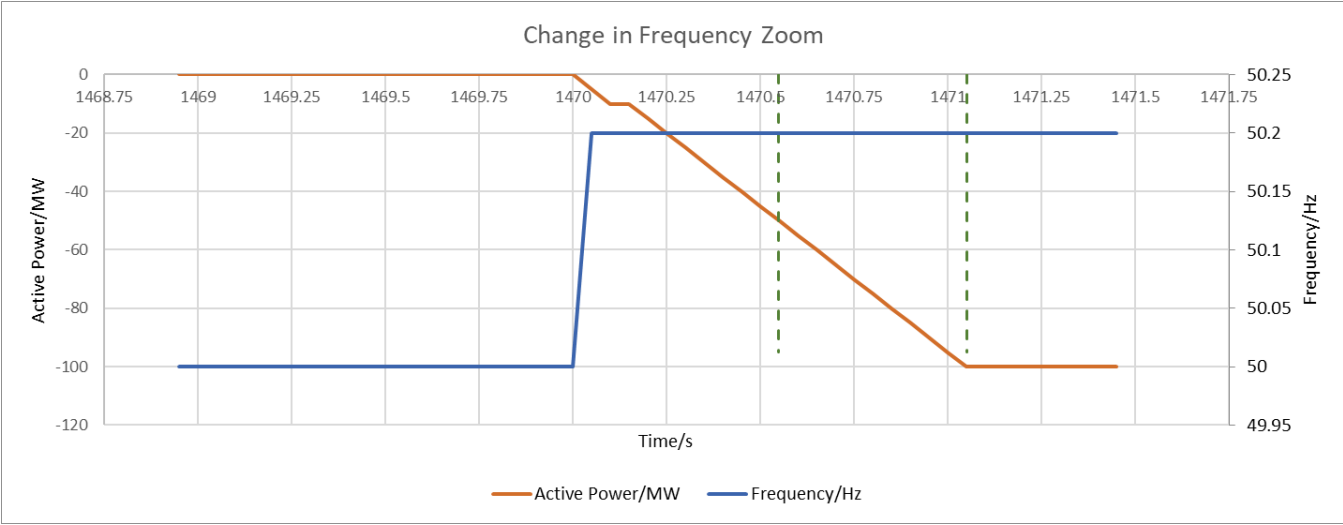




Figure 6 – Test 2.1

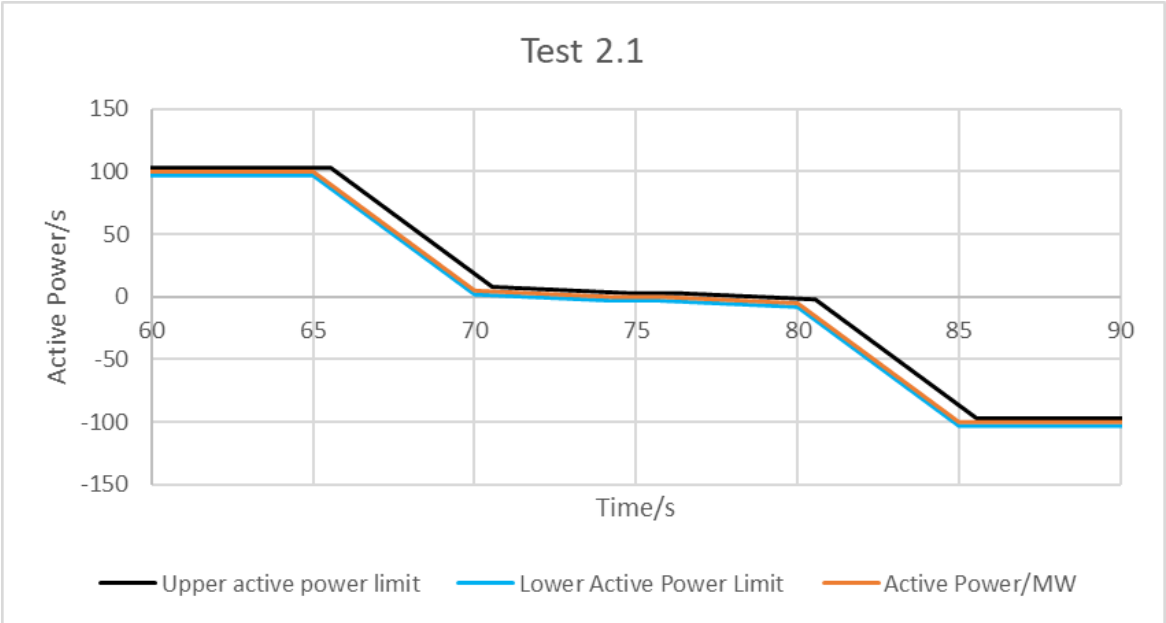


Figure 7 – Test 2.2

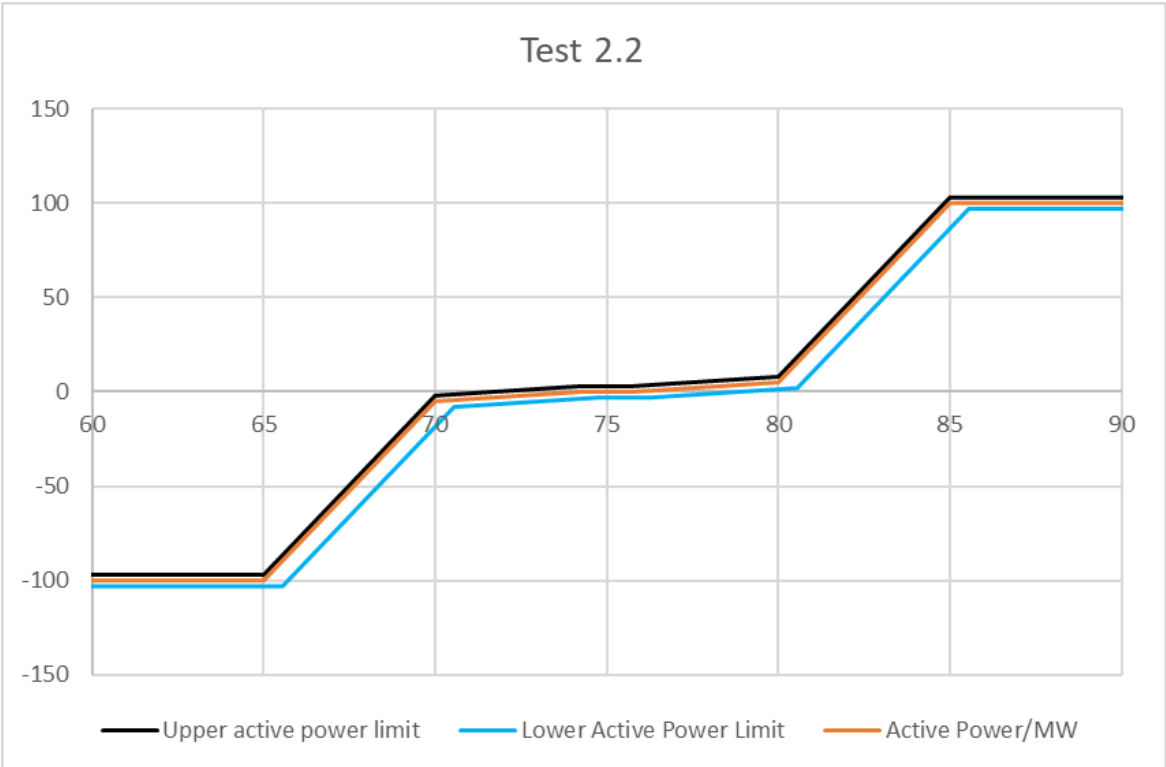


Figure 8 – Test 3.1

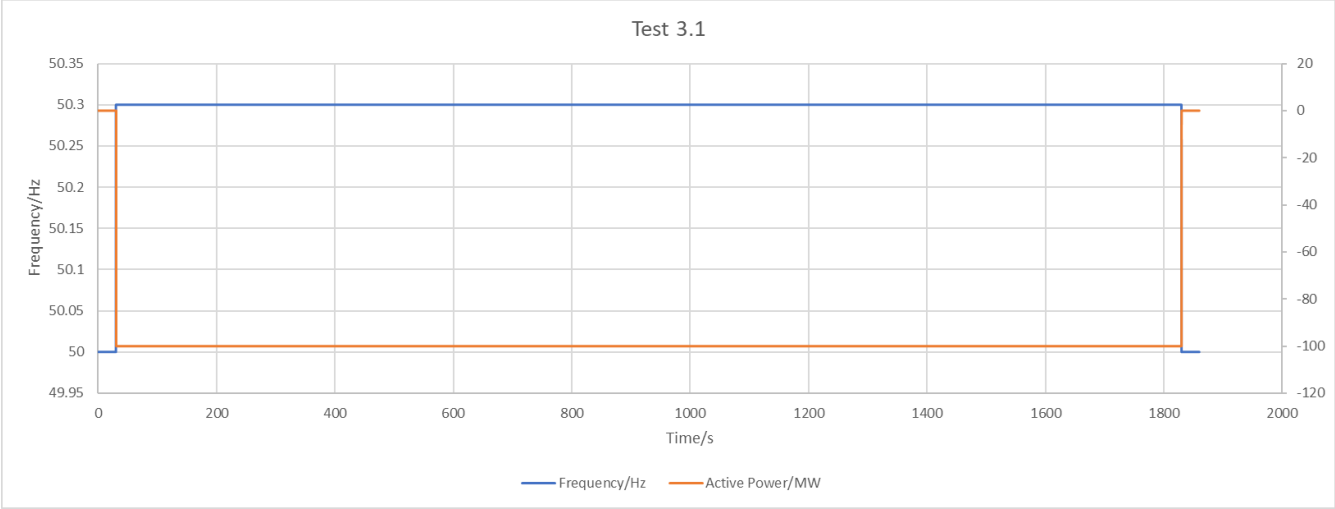


Figure 9 – Test 3.2

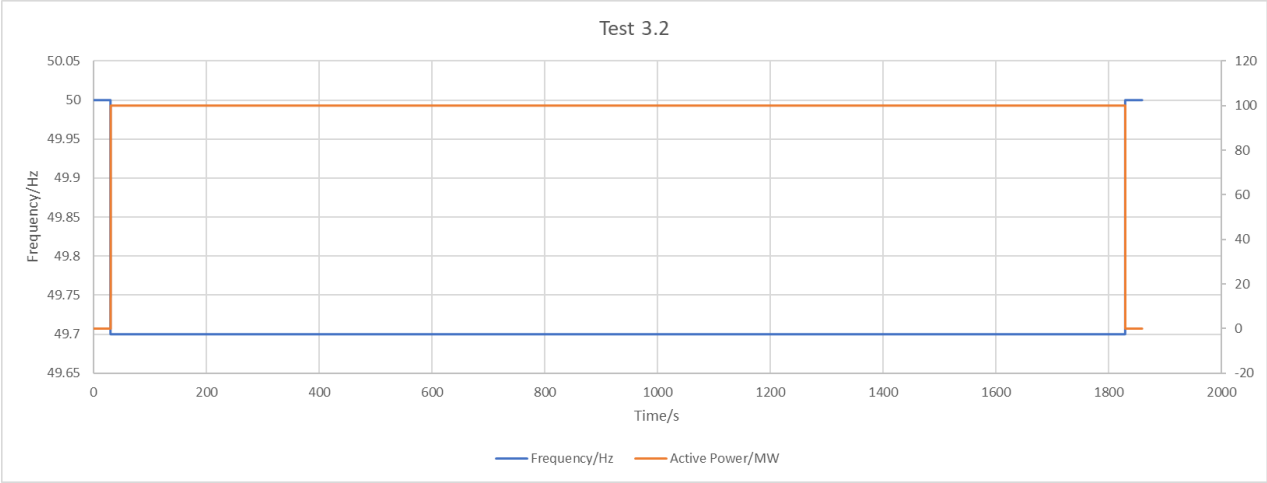
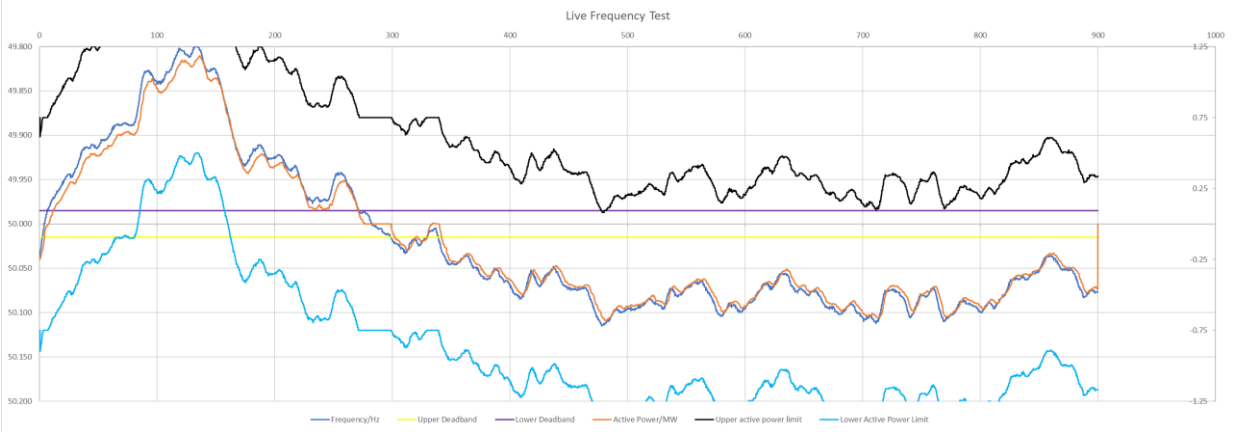


Figure 10 – Test 4



### Independent Technical Expert (ITE) Details

---

Company name

---

Primary contact name

---

Contact number /s

---

Email address

- I / We confirm that I / We the following:**
- (a) I/We am a/are Independent Technical Expert(s) (as defined in Appendix A of the NGESO's prevailing Testing Guidelines);**
  - (b) I/We have carried out an assessment of the [asset] described above in accordance with the testing guidelines set out in the Testing Guidelines;**
  - (c) the above details are, to my/our best knowledge and belief, true, accurate, complete and not misleading; and**
  - (d) the CV attached of my/our experience is to my/our best knowledge and belief, true, accurate, complete and not misleading.**

---

Signed:

Date:

---



Faraday House, Warwick Technology Park,  
Gallows Hill, Warwick, CV346DA

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