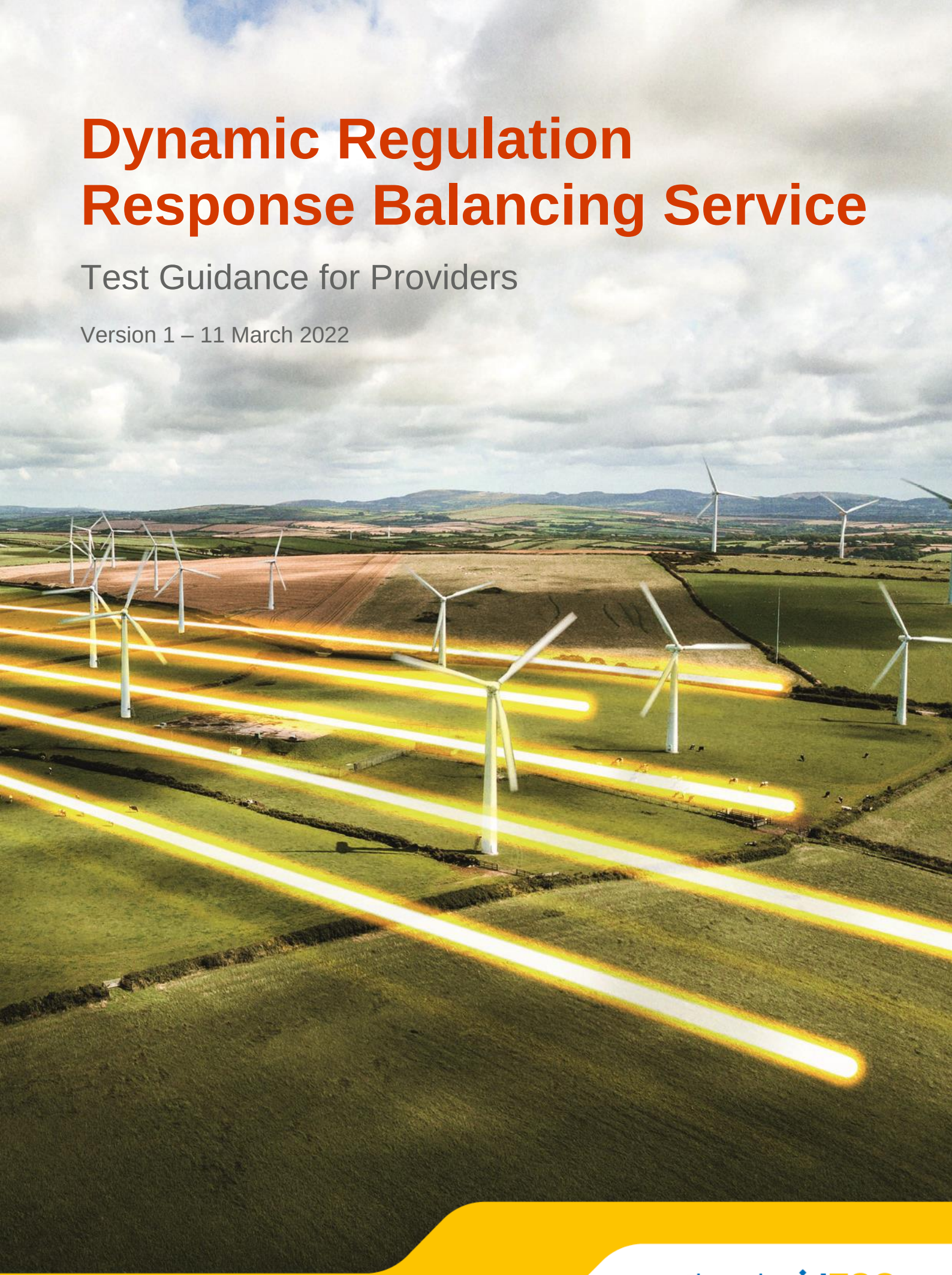
Dynamic Regulation Response Balancing Service

Test Guidance for Providers

Version 1 – 11 March 2022



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Foreword

This document aims to provide guidance to Dynamic Regulation providers to National Grid Electricity System Operator (NGESO). This document covers the testing requirements for pre-qualification assessment and reproving 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

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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Contents

Test Requirements

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Service description

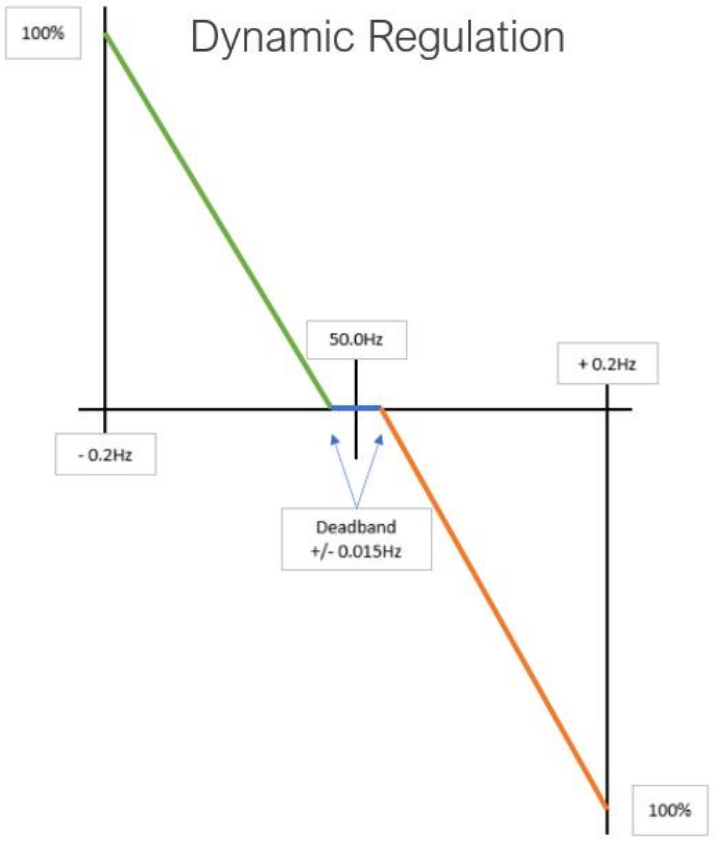
Dynamic Regulation (DR) rapidly delivers with the aim of assisting the ESO to keep frequency within operational limits. Providers of DR will help manage imbalances between demand and generation by responding quickly when frequency moves towards the edge of the operational range.

Table 1- Dynamic Regulation Service Specification

Service specification	Details
Speed of response	10 second
Pre/post fault	Pre-fault
Delivery range	±0.015Hz to ±0.2Hz
Deadband (delivery %)	±0.015Hz (0%)
Linear range (delivery %)	±0.015Hz to ±0.2Hz (100% at ±0.2Hz)
Full delivery point	±0.2Hz
Max ramp start	2 second
Time to full delivery	10 second

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

Figure 1 – Dynamic Regulation Delivery Requirements



Dynamic Regulation Test Requirements

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

Tests 1 and 2 assess response against injected frequency profiles. Test 3 assesses response whilst connected to live system frequency. The frequency profile can be injected either at site or remotely. The minimum sample rate for Test 1 is 10Hz and for Tests 2 and 3 2Hz. 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 NGESO requirement for service validation as well as being equally suitable for all types of DR 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 3 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 – Duration Test

The two tests described here can be carried out at the individual or group of assets level. These tests confirm the volume of response the asset/s can deliver, and both demonstrate response within the requisite timescales as well as provision of delivery of the asset/s for required period of the service. The sum of the demonstrated outer-envelope responses for each tested asset in an DR Unit constitute the total volume of the DR unit.

The data can be presented with the new tested volume (presented site by site) aggregated by itself, or where adding volume to an existing unit, aggregated with the step test data from that existing pre-tested unit.

The minimum sample rate for Tests 1.1 and 1.2 is 10Hz.

The frequency injections to be used are shown in **Table 2**, **Figure 2** and **Figure 3** below.

Table 2 - Test 1 Frequency Injection Profile

Time (s)	Injected Frequency (Hz)	
	Test 1.1	Test 1.2
0	50	50
30	50	50
30	49.8	50.2
3630	49.8	50.2
3630	50	50
3660	50	50

Figure 2 - Test 1.1

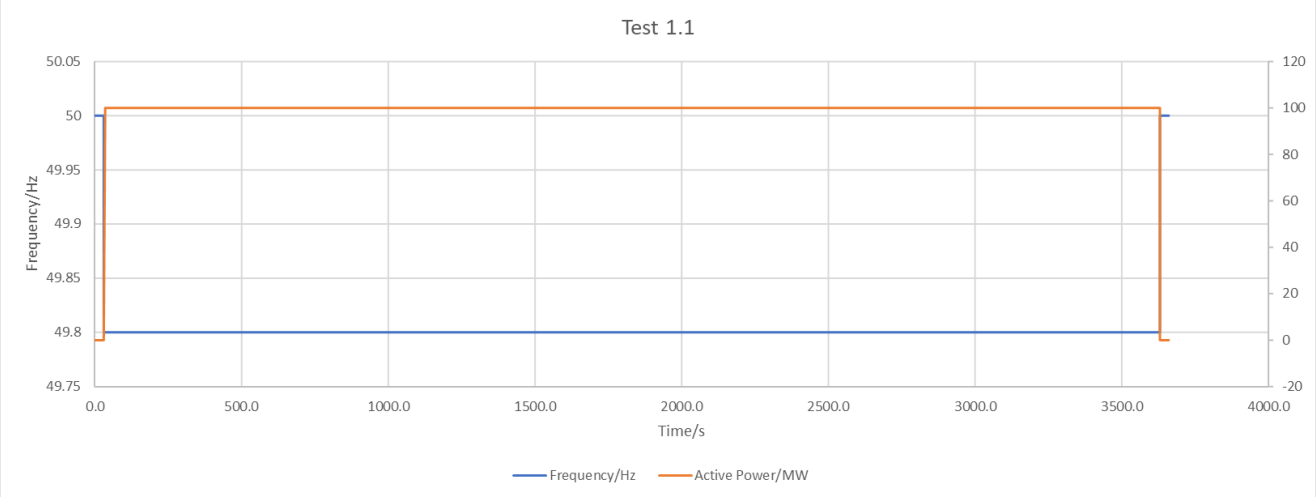
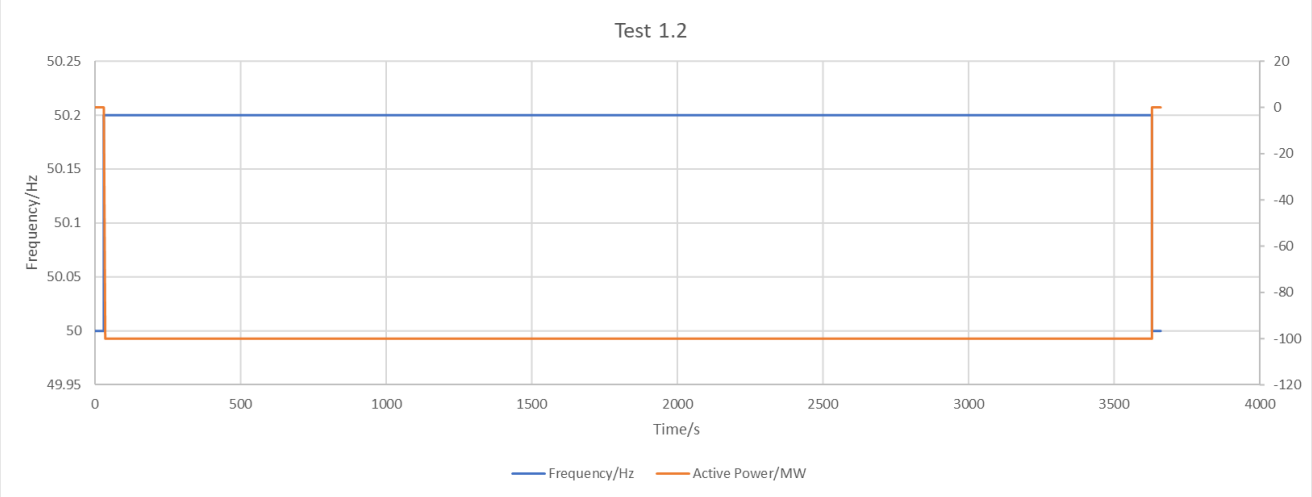


Figure 3 - Test 1.2



Assessment Criteria for Test 1

Single Asset which will be assessed as part of an aggregated facility

- Record the minimum response achieved within the 10 second to 60 minute timescale.
- How long is the response sustained? (In some cases this may be less than 60 minutes for a single asset which is part of an aggregated unit).

Pass criteria for Unit level (single asset or aggregation)

- The sum of minimum response achieved within the 10 second to 60 minute timescale constitute the total volume of the DR unit. (i.e. the minimum total response achieved within each timescale).
- Delay in response of active power due to a change in frequency is no greater than 2 seconds.
- The Unit should monotonically progress to its maximum response.
- The standard deviation of load error at steady state over a 60 minute period must not exceed 2.5% of the maximum contracted active power response. (Standard deviation is assessed from 10 seconds until 60 minutes after the frequency step)
- Sustain response for 60 minutes.
- 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

Test 2 – Response Tests

This test assesses the capability to deliver the following:

- No response inside the deadband
- Response just outside the deadband
- Proportional response at discreet frequency levels
- Response to changing frequency varying over the entire performance envelope

The minimum sample rate is 2Hz for the Response Tests.

Aggregation/Test Approach

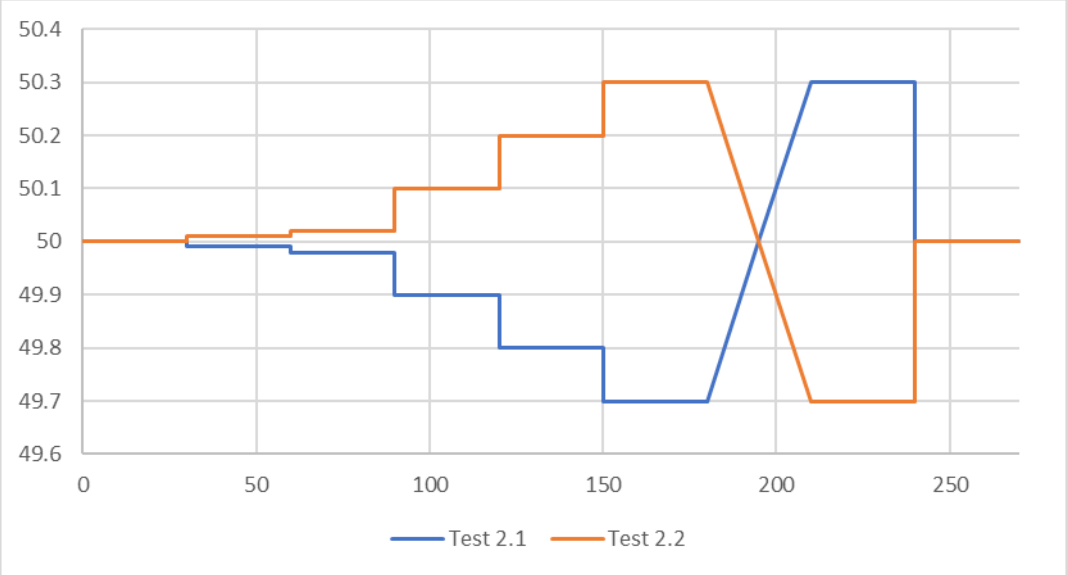
Test Scenario 1: Where a volume is being tested by itself for validation, the two response tests should be carried out on the asset/s to demonstrate the response of the asset/s for the full range of frequency.

Test Scenario 2: Where a new “in-test” volume is being added to an existing (tested) volume (which it is dependent upon for compliance), the tests would be carried out within an existing aggregated unit that has been withdrawn from the market for the test period.

Table 3 - Test 2 Frequency Injection Profiles

Time (s)	Injected Frequency (Hz)		Sub-test reference for assessment
	Test 2.1	Test 2.2	
0	50	50	
30	50	50	
30	49.99	50.01	a
60	49.99	50.01	a
60	49.98	50.02	b
90	49.98	50.02	b
90	49.9	50.1	c
120	49.9	50.1	c
120	49.8	50.2	d
150	49.8	50.2	d
150	49.7	50.3	e
180	49.7	50.3	f
195	50	50	f
210	50.3	49.7	f
240	50.3	49.7	
240	50	50	
270	50	50	

Figure 4 - Test 2 Injection Profile



Pass Criteria for Tests 2.1 and 2.2

- For 2.1a and 2.2a 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.
- Tests 2.1b and 2.2b a noticeable change in power in the correct direction is observed. This test ensures that the unit will respond to small frequency deviations outside the deadband.
- For ±0.1Hz, ±0.2Hz and steps ±0.3Hz (Tests c, d and e) the response values achieved are proportional. Also ±0.3Hz sections should reflect total maximum volume from Test 1. For each 30 second step the minimum response from 10-30seconds should be assessed against the contracted delivery volume.
- For Test 2.1f and 2.2f, active power response is within the tolerances in **Table 4** (**Figure 5** and **Figure 6**). (Performance monitoring criteria used to calculate tolerance bands)

Table 4 - Test 2 Tolerances (Without time delay to reach required delivery included)

Frequency Deviation (Hz)	Expected Response (Percentage of maximum)	Tolerance (Percentage of Maximum Contracted)
0.01	n/a	n/a
0.02	*	*
0.1	~50**	± 5%
0.2	100	± 5%
0.3	100	± 5%

**At 0.1% the actual expected response is 45.9459% due to linear delivery between 0.015Hz (deadband) to 0.2Hz

Figure 5 - Test 2.1 Tolerance

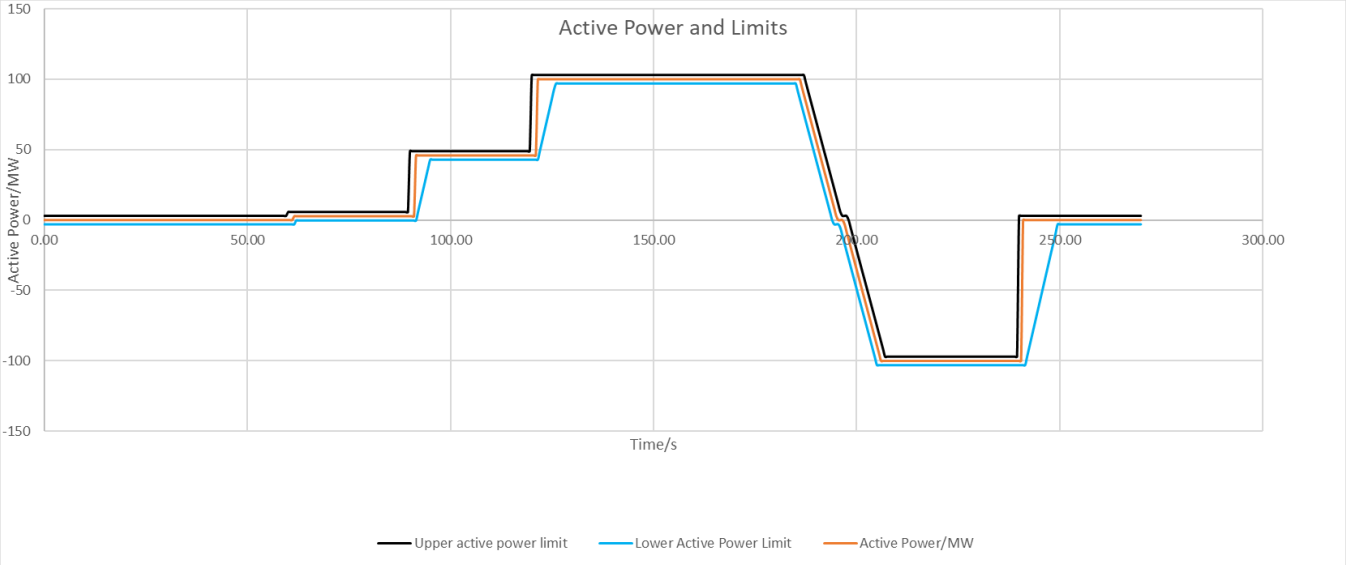
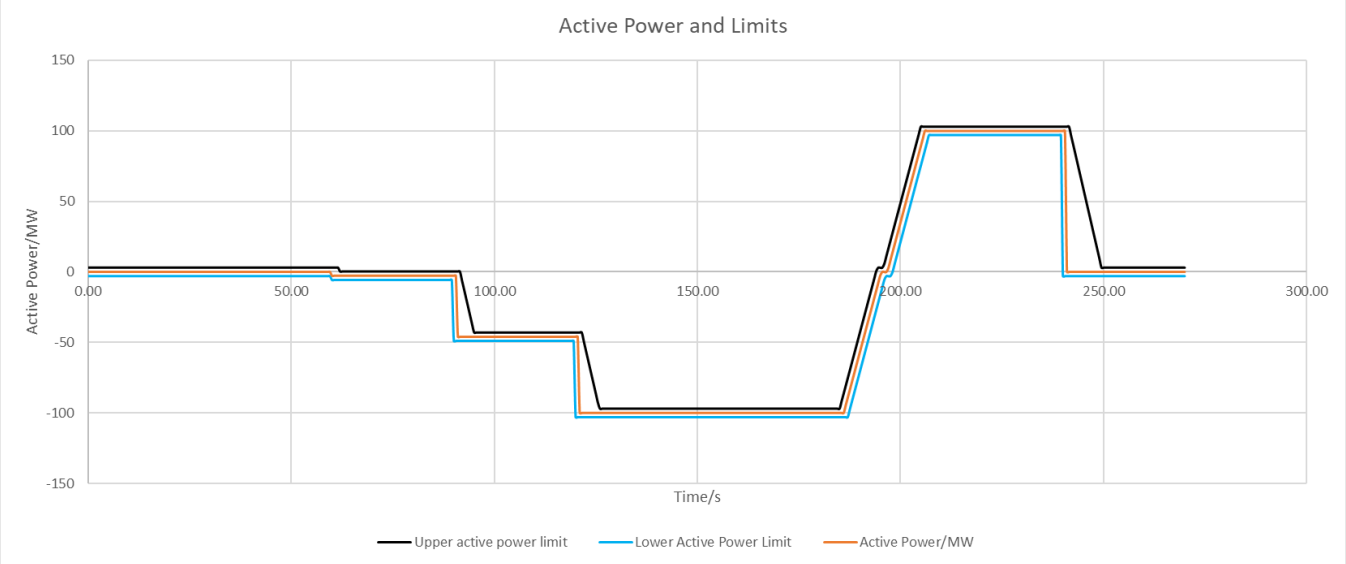


Figure 6 - Test 2.2 Tolerance



Test 3 – Live System Frequency Response Test

Test 3 assesses the unit's response to system frequency in a live environment. The minimum sample rate for this test is minimum 2Hz and duration is 1 hour 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 (± of 5% of 50Hz).

Aggregation

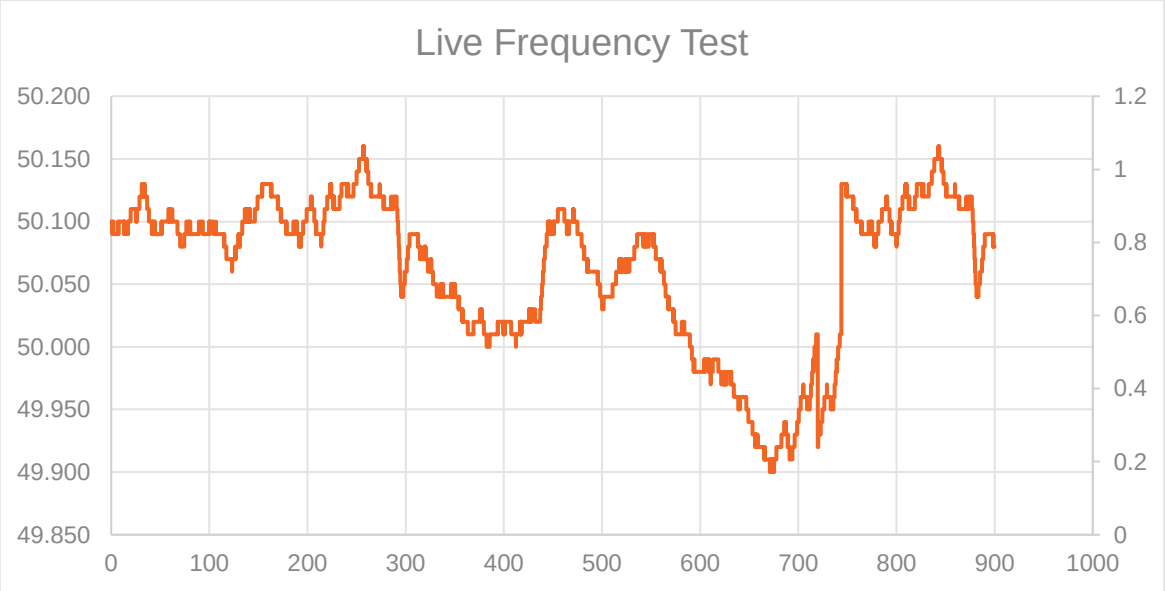
The options for the live test are as follows.

1. A single asset capable of meeting DR criteria on its own.
2. A group of 'new' assets capable of meeting DR criteria can be tested simultaneously. These could then contract as a standalone unit or be added to an existing DR Unit.
3. New asset/s to be added to an existing DR Unit can carry out a live test where the new "in-test" assets would be added to the existing DR Unit and run following the system frequency (equivalent of being in-market) for a period of 1 hour. (See Appendix F for further details).

Pass Criteria for Test 3

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

Figure 7 - Sample System Frequency



Appendices

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Appendix A - Independent Technical Expert (ITE)

The Dynamic Regulation 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 5**. All success criteria are subject to the stated limit of error/accuracy threshold.

Table 5 - Limits of error and minimum sample rates for Dynamic Regulation Testing

	Limit of error/ Accuracy threshold	Minimum Sample rate Test 1	Minimum Sample rate Tests 2 and 3
Injection Frequency (Hz)	±0.01 Hz	10Hz	2Hz
Active Power (MW)	Please see pass criteria	10Hz	2Hz

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 Regulation Test Data Format

Table 6 - Sample Dynamic Regulation Test Data Format

Time/s	Injected Frequency/s	Measred Power/MW
0.0	50.00	0.00
0.5	50.00	0.00
1.0	50.00	0.00
1.5	50.00	0.00
2.0	50.00	0.00
2.5	50.30	5.00
3.0	50.30	5.00
3.5	50.30	5.00
4.0	50.30	5.00
4.5	50.30	5.00
5.0	50.30	5.00
5.5	50.30	5.00
6.0	50.00	0.00
6.5	50.00	0.00
7.0	50.00	0.00
7.5	50.00	0.00
8.0	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 3 replace ‘Injected Frequency’ with ‘Measured Frequency’.

Appendix D – Dynamic Regulation Test Assessment

Excel Analysis Tool published with User Guide.

See Test certificate template in Appendix E for further guidance.

Appendix E – Dynamic Regulation Test Certificate Template

Please use this Test Certificate format and submit to NGESO, 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
Single Asset which will be assessed as part of an aggregated facility			
1	Record the minimum response achieved within the 10second to 30minute timescale.	N/A	Note result here (See Figure …)
1	Record how long is the response sustained	N/A	Note result here. (Some assets which are part of an aggregated unit may not be able to maintain response for 30 minutes.)
Pass criteria for Unit level (single asset or aggregation)			
1	Delay in response of active power due to a change in frequency is no greater than 2 seconds.	Pass	a response was observed within 2 seconds of the frequency change. This is illustrated in Figure …
1	Record the minimum response achieved within the 10second to 30minute timescale.	Pass	Record result here. Should align with the in-test volume in Table 1.
1	The Unit should monotonically progress to its maximum response.	Pass	Refer to Figures below.
1	The standard deviation of load error at steady state over a 60 minute period must not exceed 2.5% of the maximum contracted active power response.	Pass	Standard deviation is assessed from 10 seconds until 60 minutes after the frequency step.
1	Sustain response for 60 minutes.	Pass	
2.1a 2.2a	No response within the deadband	Pass	
2.1b 2.2b	A noticeable change in power in the correct direction is observed.		
2.1,2.2 c,d,e	For ±0.1Hz, ±0.2Hz and steps ±0.3Hz (Tests c, d and e) the response values achieved are proportional.	Pass	
2.1c-f 2.2c-f	Active power response is within the allowed tolerances.	Pass	Show in figure below with tolerance bands overlaid.
3	Provide an active power response consistent with the contracted performance timescales.	Pass	
	Overall Test Result	**PASS**	

Test Result Graphs

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

Figure 1 – Test 1.1

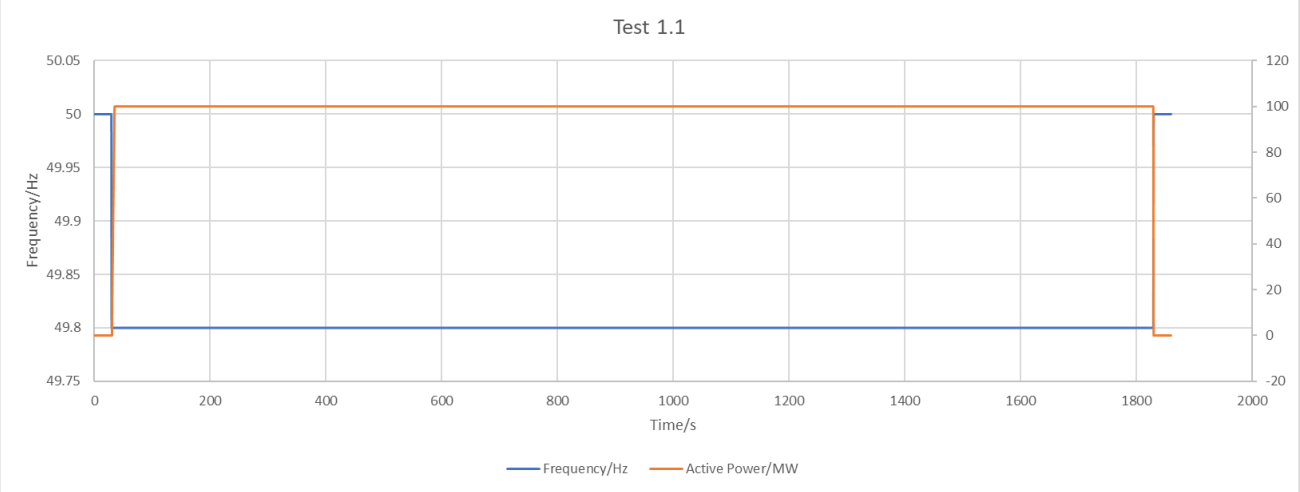


Figure 2 – Test 1.1 Change in Frequency Zoom

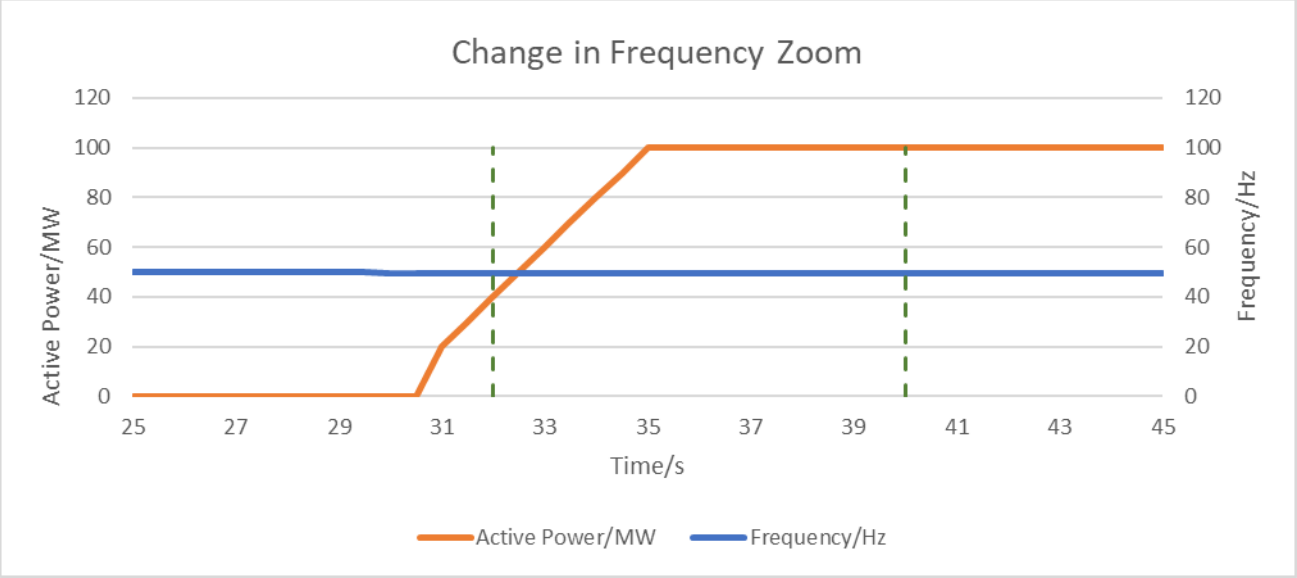


Figure 3 – Test 1.2

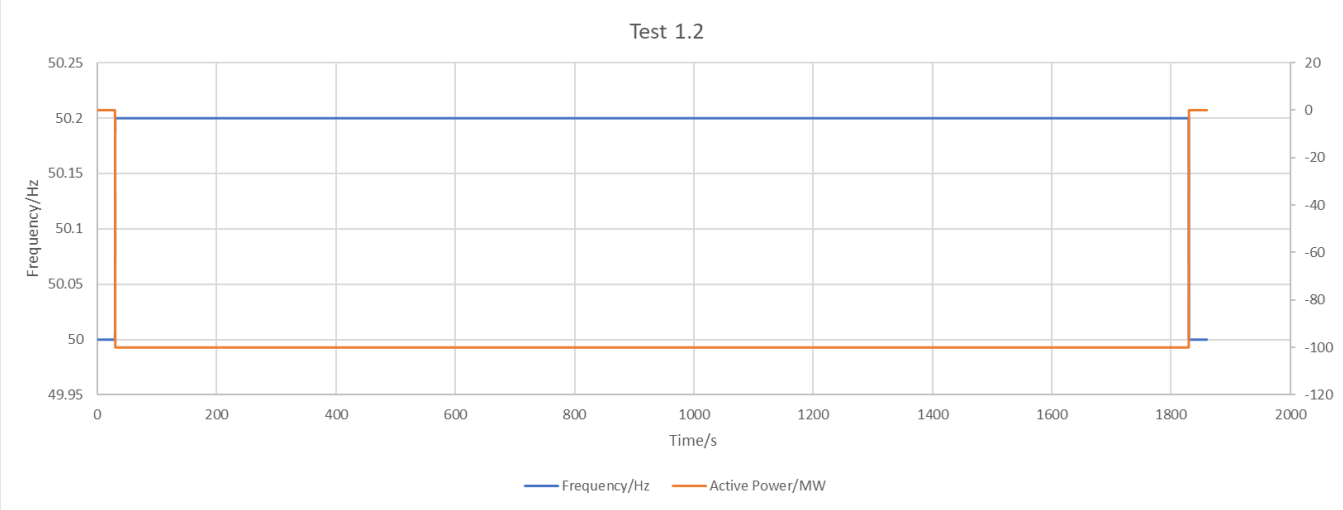


Figure 4 – Test 2.1

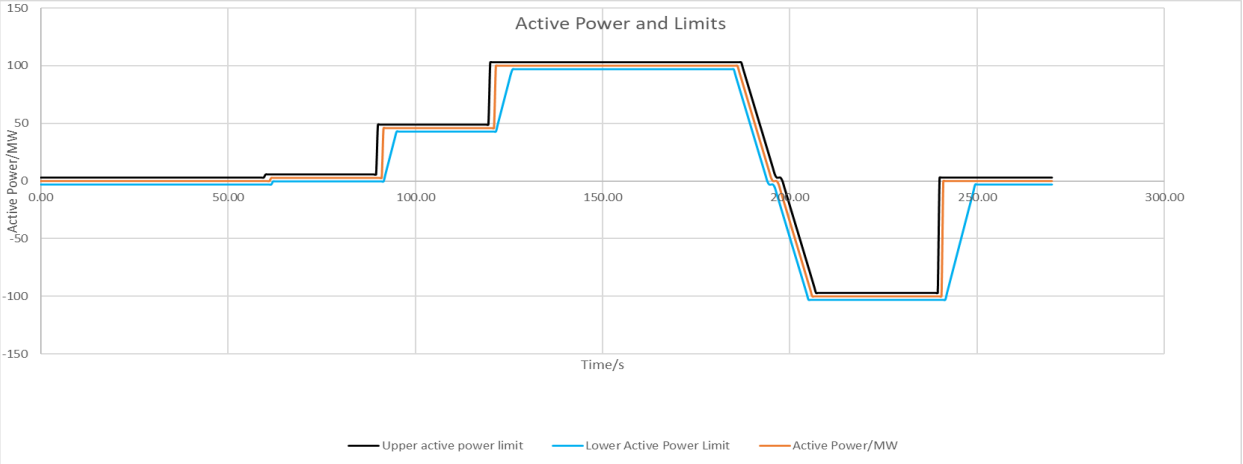


Figure 5 – Test 2.2

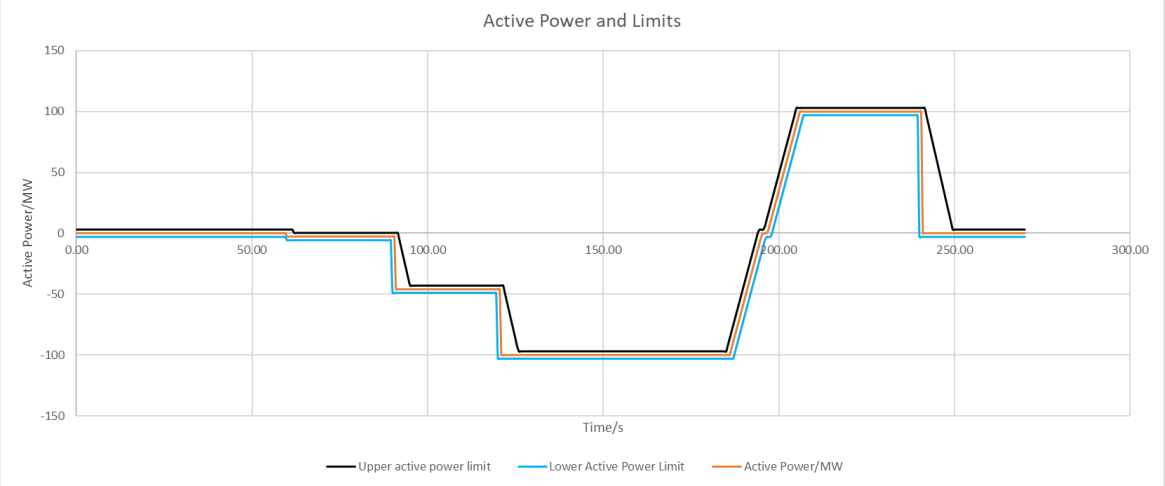
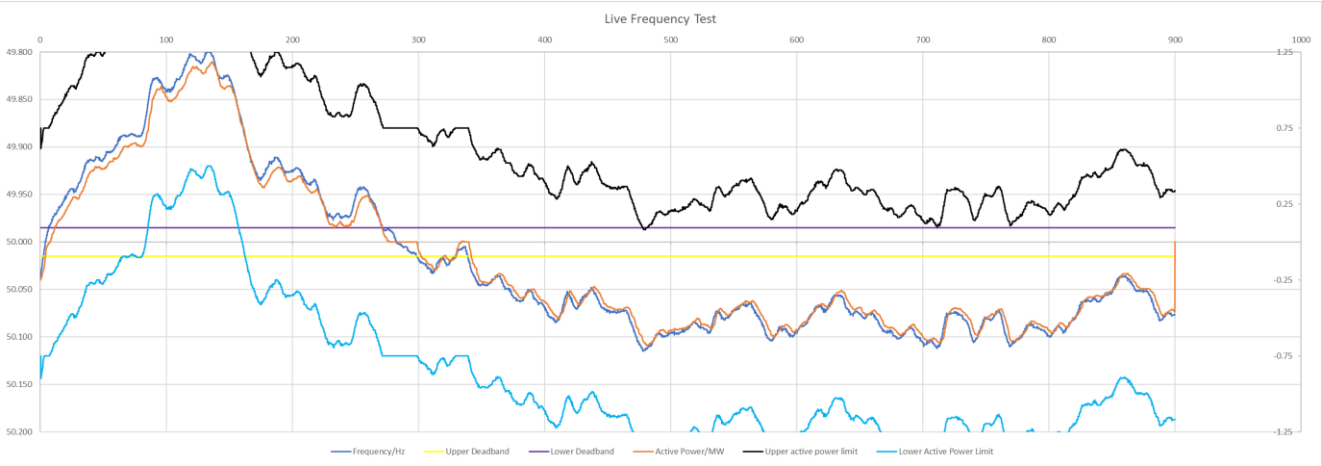


Figure 6 – Test 4



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:

Appendix F - Test 3 Approach

The options for the live test are as follows.

1. A single asset capable of meeting DR criteria on its own. The single asset would be run following the system frequency (equivalent of being in-market) for a period of 1 hour
2. A group of 'new' assets capable of meeting DR criteria can be tested simultaneously. The 'new' assets would be aggregated and run following the system frequency (equivalent of being in-market) for a period of 1 hour. This would validate that the volume responds as required to system frequency in a live environment. This group of assets could then contract as a standalone unit or be added to an existing DR Unit.
3. New asset/s to be added to an existing DR Unit can carry out a live test where the new "in-test" assets would be added to the existing DR Unit and run following the system frequency (equivalent of being in-market) for a period of 1 hour. Where the new "in test" assets were being added to a DR Unit already in market, then they should be combined and aggregated with the live "in-market" unit to show the overall portfolio operating as required based on the "in-market" and "in-test" combined volume. The existing portfolio does not need to be withdrawn from market during this test but NGESO should be informed.

The test approach, described in option 3 above, would be carried out for an agreed 1-hour period with NGESO. This agreement will detail what assets are being added to the portfolio and the expected resulting change from its standard operation. For example, if six assets adding up to a 2MW total were added to a 10MW portfolio, the portfolio would usually be expected to behave like a 12MW portfolio. This validates that the combined volume responds as required against the system frequency in a live environment.

Data submission for this test shall include the frequency, response of the existing portfolio, response of each new asset in the new combined portfolio, and the combined total response of the portfolio.

If testing for Option 3, above, the frequency data and combined "in-test" and "in-market" volume response data would be submitted for validation

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

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