nationalgridESO

Dynamic FFR Excel Analysis Tool 2019

User Guide

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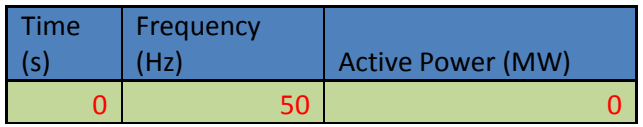
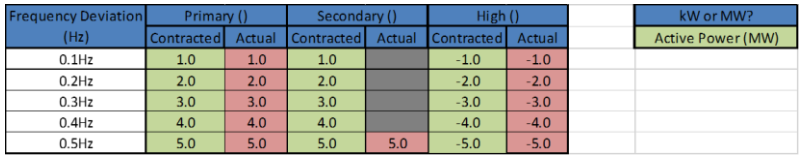
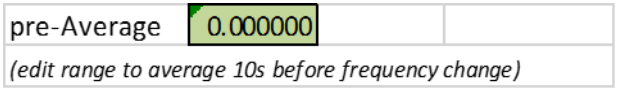
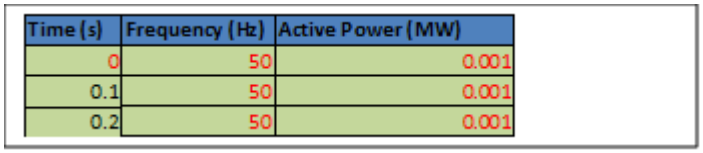
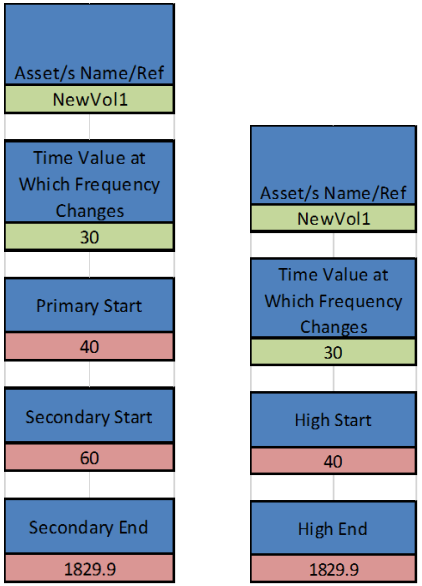
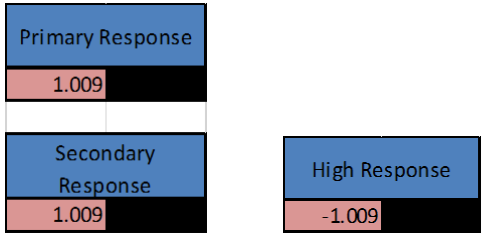
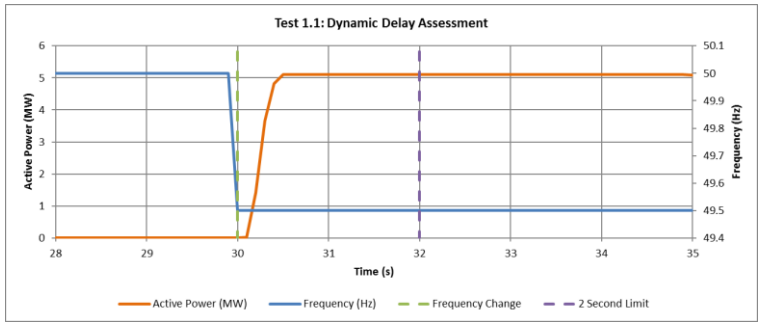
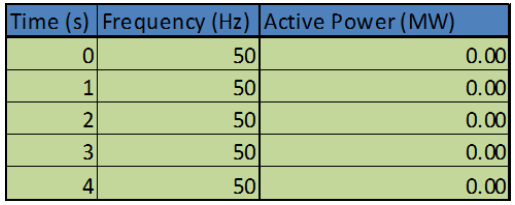
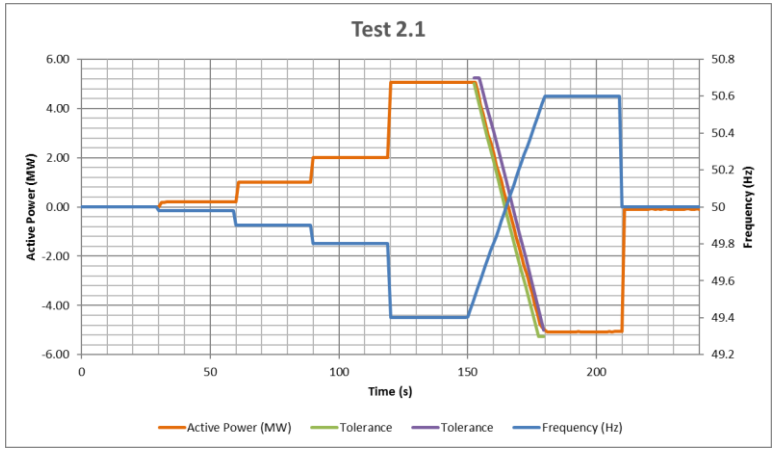
Introduction

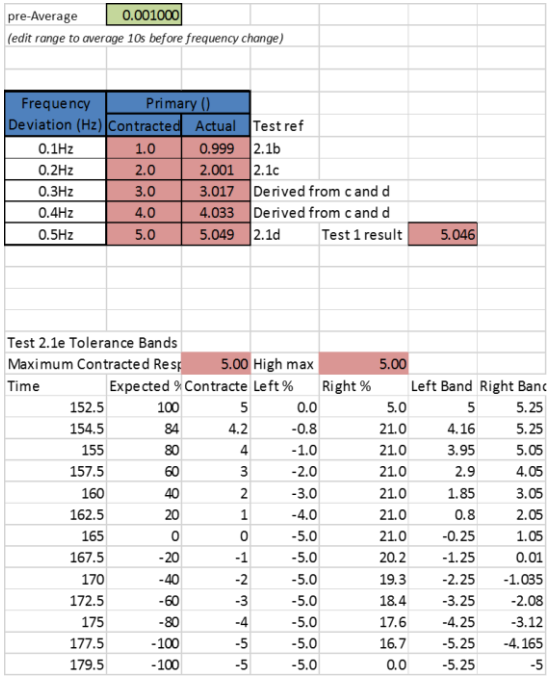
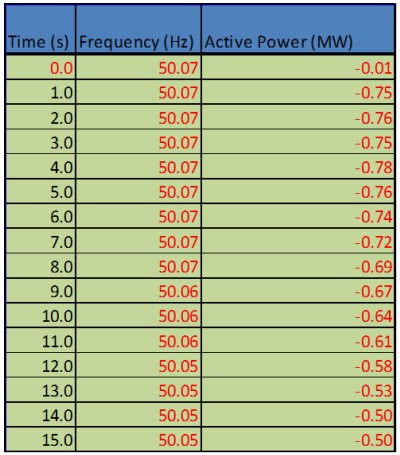
This User Guide describes how to use the 'NGESO FFR Dynamic Analysis Tool 2019' to assess pre-qualification test results as specified in FFR testing Guidance for Providers wishing to enter into a contract to provide Dynamic Firm Frequency Response. The following sections are included:

- Prepare Test Data
- Populate Excel Analysis Tool
- Analyse Results against pass criteria
- Test Report

Step	Action	Description	Examples
Prepare Test Data			
1	Format test data to be pasted into Tool.	Where applicable test data should be aggregated on a separate sheet to paste the total test volumes into the Tool.	
2	Overall response values should be copied into the Tool. e.g. Total aggregated data or, where baseline and measured power are provided, these need to be subtracted to provide a response value.	The Tool assumes that the response looks like generation i.e. Low frequency=generation increase. High frequency=generation decrease Check response values are +ve or -ve accordingly.	
Populate Excel Analysis Tool			
3	General	Green cells can be edited. Pink cells are automatically populated. Formulae and tolerance bands assume test injections are identical to the published version. If not, timings/ ranges may need to be altered.	
4	Clear previous test data	In each Test data tab, delete the previous data from ‘Frequency’ and ‘Active Power’ columns.	
5	‘Response’ tab Copy contracted values into the green cells in ‘response’ tab. Check units are the same as raw data.	Units in this table should be the same as those in the measured test data. Note: High Frequency response values should be negative.	

Step	Action	Description	Examples
	Drop down cell J7 and select correct units.	'Actual' response values will be automatically populated from Test 1 and 2 results.	
6	Pre-frequency change average: For Tests 1 and 2, to provide a reference from which to measure the response delivered, the average power is calculated for the 10 seconds before the frequency change.	Check/adjust the range to cover the 10s prior to the frequency change Cell I16 in Test 1 tabs, '=AVERAGE(C202:C301)' Cell F4 in Test 2 tabs '=AVERAGE(C22:C31)'	
7	Test 1.1, 1.2 Single Asset tabs Copy required data from raw file (check units correct)	These tabs should be used where there is a new asset or group of assets which will be assessed as part of an aggregated unit. These tabs can be duplicated and populated for several different assets as required.	
8	Test 1.1, 1.2 Single Asset tabs Edit Green Cells - Asset/s Name/Ref - Time Value at Which Frequency Changes	Primary and Secondary Start, and secondary end, or High start and end, times filled in automatically. **Note:** Default assumption that this asset can sustain maximum response for 30 minutes. If not the case, adjust cell adjust cell E17 'Secondary End' for Test 1.1 and E13 'High End' for Test 1,2 accordingly and clearly state in test report.	

Step	Action	Description	Examples
9	Test 1.1, 1.2 Single Asset tabs The Tool calculates the response values shown by taking the **minimum** response value achieved for each timescale.	e.g Primary response = MINIMUM (from 10 to 30 seconds following start of 0.5Hz frequency step) minus (pre-average).	
10	Test 1.1 and 1.2 Total Repeat Steps 6, 7 and 8	Used for the total test volume. In addition to the total Primary, Secondary and High frequency response values, this also calculates Standard Deviation over the 30 minute period and displays an additional close up graph to check that the total unit starts to respond within 2 seconds.	
11	**Test 2.1 and 2.2** Enter data in the same way as for Test 1.	**Note:** All calculations and tolerance bands assume frequency injection aligns with the published version.	 

Step	Action	Description	Examples
12	Test 2.1 and 2.2	Pre-average as for Step 5 above. For Tests 2b, c and d, the 'Actual' values are calculated as the minimum response observed from 10 – 29 seconds after each step. e.g. Test 2.1.c 'Actual' = MIN(C102:C121)-F4 For Test 2.1e the tolerance bands are automatically calculated but need to align with published frequency injection.	
13	Test 3 Copy required data from raw file.		

pre-Average 0.001000

(edit range to average 10s before frequency change)

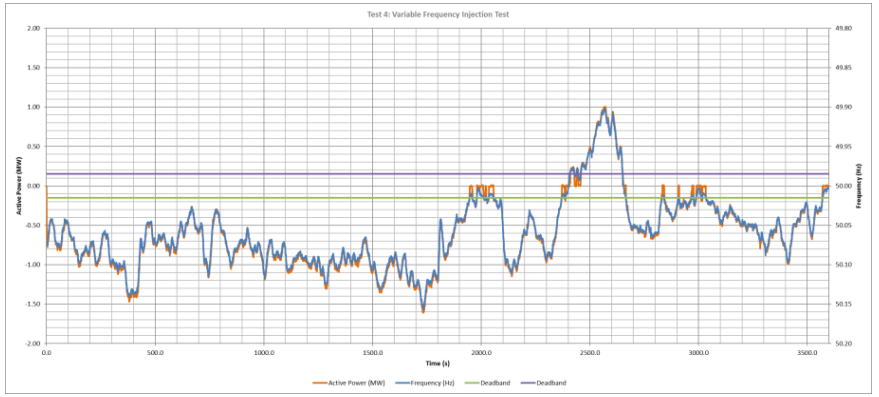
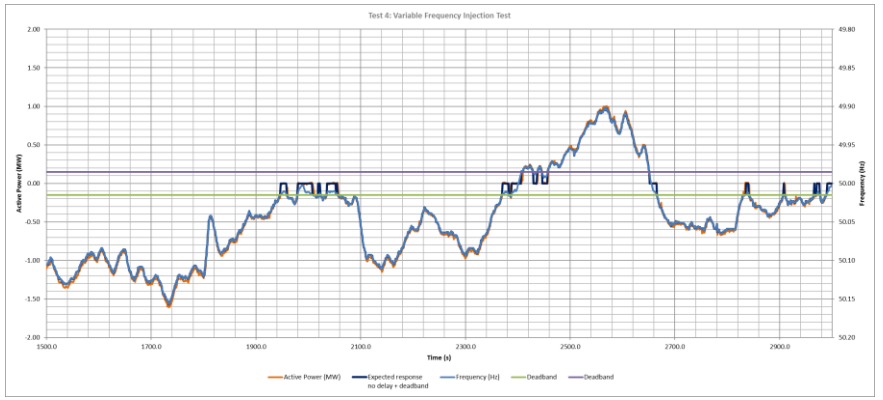
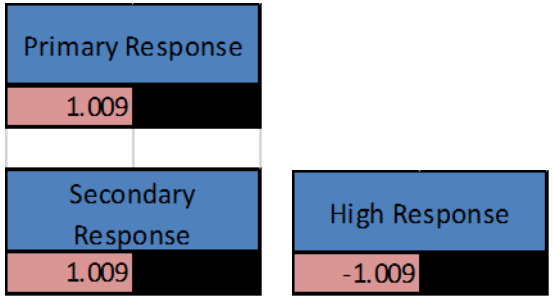
Frequency Deviation (Hz)	Primary () Contracted	Actual	Test ref		
0.1Hz	1.0	0.999	2.1b		
0.2Hz	2.0	2.001	2.1c		
0.3Hz	3.0	3.017	Derived from c and d		
0.4Hz	4.0	4.033	Derived from c and d		
0.5Hz	5.0	5.049	2.1d	Test 1 result	5.046

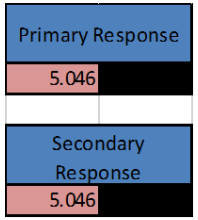
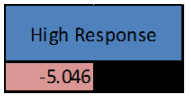
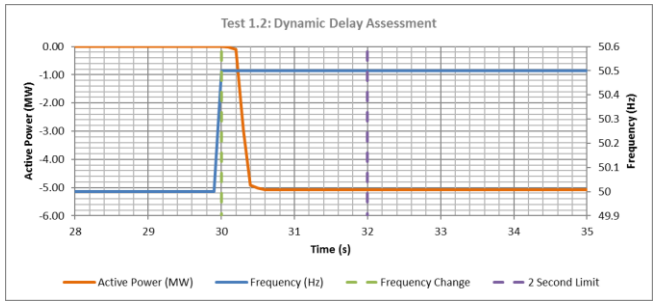
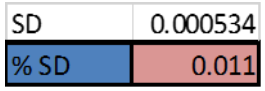
Test 2.1e Tolerance Bands

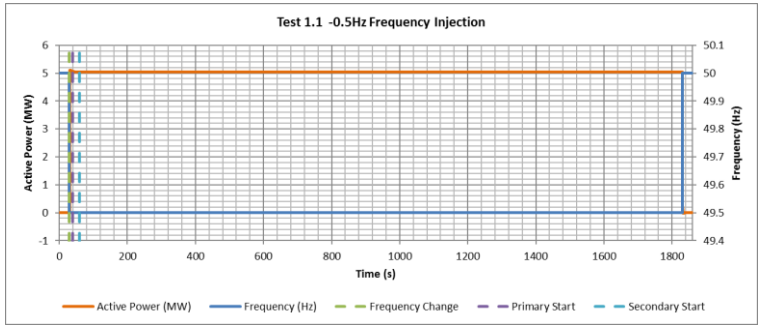
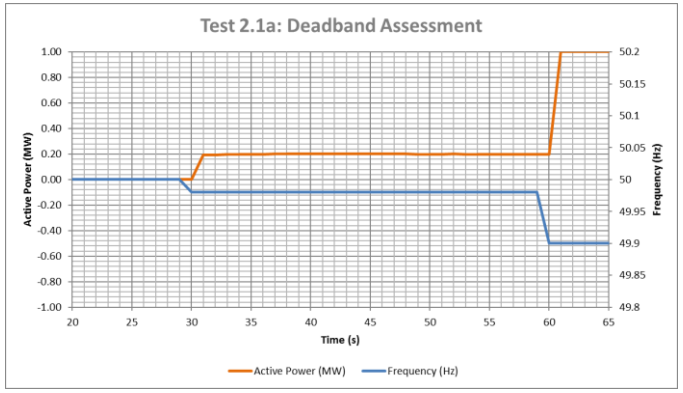
Maximum Contracted Resp 5.00 High max 5.00

Time	Expected %	Contracte	Left %	Right %	Left Band	Right Banc
152.5	100	5	0.0	5.0	5	5.25
154.5	84	4.2	-0.8	21.0	4.16	5.25
155	80	4	-1.0	21.0	3.95	5.05
157.5	60	3	-2.0	21.0	2.9	4.05
160	40	2	-3.0	21.0	1.85	3.05
162.5	20	1	-4.0	21.0	0.8	2.05
165	0	0	-5.0	21.0	-0.25	1.05
167.5	-20	-1	-5.0	20.2	-1.25	0.01
170	-40	-2	-5.0	19.3	-2.25	-1.035
172.5	-60	-3	-5.0	18.4	-3.25	-2.08
175	-80	-4	-5.0	17.6	-4.25	-3.12
177.5	-100	-5	-5.0	16.7	-5.25	-4.165
179.5	-100	-5	-5.0	0.0	-5.25	-5

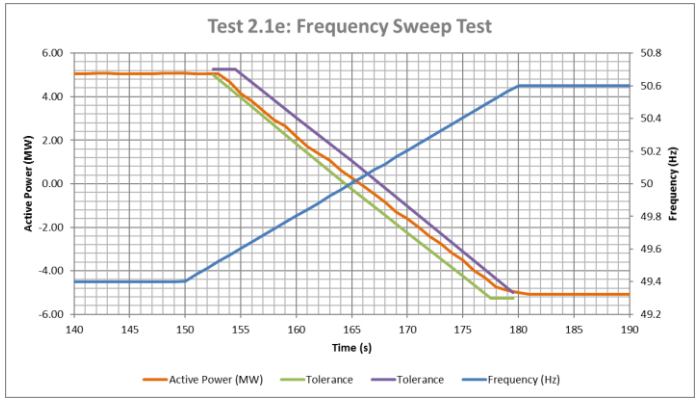
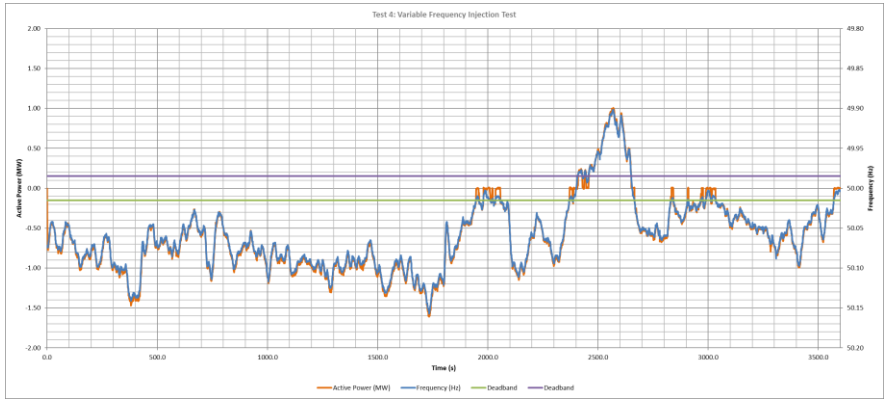
Time (s)	Frequency (Hz)	Active Power (MW)
0.0	50.07	-0.01
1.0	50.07	-0.75
2.0	50.07	-0.76
3.0	50.07	-0.75
4.0	50.07	-0.78
5.0	50.07	-0.76
6.0	50.07	-0.74
7.0	50.07	-0.72
8.0	50.07	-0.69
9.0	50.06	-0.67
10.0	50.06	-0.64
11.0	50.06	-0.61
12.0	50.05	-0.58
13.0	50.05	-0.53
14.0	50.05	-0.50
15.0	50.05	-0.50

Step	Action	Description	Examples
14	Test 3 Frequency axis is reversed. Frequency Axis Range should mirror corresponding active power in response table.	For the 5MW sample Unit shown, the frequency range 50.2Hz to 49.8Hz aligns with -2MW to +2MW.	
15	Test 3 Expected Response	Column E in the Test 3 tab calculates the expected response against frequency (without considering delay) and gives a value of zero if the frequency is inside the deadband range.	
Analyse Results against pass criteria.			
16	**Test 1.1 and 1.2 - Single Asset** which will be assessed as part of an aggregated facility.	Record Primary/Secondary/High Note duration	

Step	Action	Description	Examples
17	**Test 1.1 and 1.2 Total** Minimum total response achieved within each timescale can be found in the Test 1 'total' tabs and will also populate the 'Actual' values for 0.5Hz frequency deviation in the 'Response' tab.		  Frequency Deviation (Hz) / Primary () Contracted / Primary () Actual / Secondary () Contracted / Secondary () Actual / High () Contracted / High () Actual 0.1Hz: 1.0 / 1.0 / 1.0 / -1.0 / -1.0 0.2Hz: 2.0 / 2.0 / 2.0 / -2.0 / -2.0 0.3Hz: 3.0 / 3.0 / 3.0 / -3.0 / -3.0 0.4Hz: 4.0 / 4.0 / 4.0 / -4.0 / -4.0 0.5Hz: 5.0 / 5.0 / 5.0 / 5.0 / -5.0 / -5.0
18	**Test 1.1 and 1.2 Total** Check delay in response of active power due to a change in frequency is no greater than 2 seconds.	Dynamic delay assessment graph For each test, alter the dynamic delay graph so the x-axis shows a close up before and after the frequency change point.	
19	**Test 1.1 and 1.2 Total** The Unit should progressively change to its maximum response	Shown in the Delay Assessment graph (Step 18). The unit should start to respond within 2 seconds and progress monotonically towards its maximum response.	
20	**Test 1.1 and 1.2 Total** Check that the standard deviation of load error at steady state over a 30 minute period does not exceed 2.5% of the maximum contracted active power response.	Standard deviation is assessed from 10 seconds until 30 minutes after the frequency step, unless the contracted values for primary and secondary are different. In this case, standard deviation is assessed from 30 seconds until 30 minutes after the frequency step.	

Step	Action	Description	Examples
		Note: SD calculation assumes Primary = Secondary. If Primary ≠ Secondary then change cell J13 formula to =STDEV.P(INDIRECT(**J9**&":"&J10))	
21	**Test 1.1 and 1.2 Total** Check response is sustained for 30 minutes		
22	**Test 2.1 and 2.2** For Tests 2.1a and 2.2a check that a noticeable change in power in the correct direction is observed.		
23	**Test 2.1 and 2.2** See Step 12 for Test 2.1 and 2.2 b, c and d. These values will populate the 'Response' tab Check that minimum of the sampled values of active power within primary, secondary and high frequency	For each test the 'Actual' values are taken from the (minimum value observed within Primary, Secondary or High Frequency response timescales) minus (Pre-frequency change average) The error shown in the table opposite (from 'Response' tab) is a percentage of the expected	

Frequency Deviation (Hz)	Primary ()				Secondary ()			High ()		
	Tolerance	Contracted	Actual	Error %	Contracted	Actual	Error %	Contracted	Actual	Error %
0.1Hz	5%/-4%	1	1.00	-0.10	1	0.00	-100.00	-1	-1.00	0.02
0.2Hz	5%/-3%	2	2.00	0.05	2	0.00	-100.00	-2	-2.00	0.04
0.3Hz	5%/-2%	3	3.02	0.57	3	0.00	-100.00	-3	-3.02	0.40
0.4Hz	5%/-1%	4	4.03	0.82	4	0.00	-100.00	-4	-4.04	0.76
0.5Hz	5%/-0%	5	5.05	0.92	5	5.05	0.92	-5	-5.05	0.92

Step	Action	Description	Examples
	timescales are within the allowable tolerances.	response for that frequency deviation. = ('Actual'-'Contracted') / Actual'*100 **Note**: Secondary response is not assessed here for 0.1Hz- 0.4Hz frequency deviation.	
24	**Test 2.1e and 2.2e** Check that active power response is within the tolerances specified in Test Guidance.	If a small number of data samples fall outside the tolerance bands, this should be investigated and explained.	
25	**Test 3** Check that active power response is consistent with the contracted performance within Primary, Secondary and/or High frequency response timescales.	The frequency axis has been reversed. Scale both vertical axes to be consistent with the total test volume. Once displayed this way, the active power can be clearly seen performing as expected. Inside the deadband, the active power response may move to zero. (There is no obligation to have a deadband. If the Unit does continue to respond within the deadband then it should respond proportionally with frequency.) Any unusual or unexpected performance should be investigated and explained. A re-test may be required.	

Step	Action	Description	Examples
Test Report			
26	Write report giving feedback on test results.	See report template	