METER ERROR REPORT

FINAL

Reconcile?	Y

Safety Issue?	Y/N

Thesis Report No.	

1. EXECUTIVE SUMMARY

SITE NAME	Dyffryn	
LDZ	WS	
START DATE (actual)		
LAST GOOD DATE	6th October 2014	
END DATE	21st July 2015	
SIZE OF ERROR (No reconciliation required if under 0.1%)	0.1929% over-registration (4.37 GWh)	
ESTIMATE – Y/N?		
ROOT CAUSE	Failed validation checks for pressure ADC on stream 1 and temperature ADC on both streams. Incorrect k-factors in use for stream 2.	
ANALYSIS	Recalculation of volumes using corrected pressure, temperature and k-factor.	
METER TYPE	USM	
AUTHOR	H Richardson	
CHECKED BY	S Kimpton	
ACCEPTED BY WWU NETWORK		
RECONCILIATION	Distribution	Transportation

2. BACKGROUND

Dyffryn has a duty/standby Ultrasonic meter stream using a gas chromatograph for CV determination and PTZ correction.

During the annual validation the CP4a test (ADC Pressure Check) for stream 1 and the CP4e test (ADC Temperature Check) for both streams failed on 9th July 2015. The ADCs were subsequently fixed on 9th July 2015. The annual validation for stream 1 took place on 6th and 8th October 2014 for CP4a and CP4e respectively. The annual validation for stream 2 took place on 17th September 2014.

One of the k-factors for the USM on stream 2 has been identified as being incorrectly calculated at the certificating office. The meter was commissioned in September 2013 and the k-factors corrected in December 2015.

Stream 2 was in use between 6th October 2014 and 21st July 2015 and therefore failure of stream 1 pressure and temperature ADCs have not contributed to the meter error.

In summary, errors to be accounted for are as follows:

- Stream 2 temperature ADC errors between 6th October 2014 and 9th July 2015

- Stream 2 K-factor error between 6th October 2014 and 21st July 2015.

Contributing to the complexity of this meter error report is that a large amount of RBD data is missing during this time period. Significant gaps in data occur between:

- 6th October 2014 – 23rd March 2015

- 12th – 15th May 2015

3. ERROR QUANTIFICATION AND IMPACT

3.1 ADC Errors

The temperature measurements were corrected for 'As Found' errors shown in Table 1 for Stream 2 when the recorded measurement was in the appropriate range.

Temperature (°C)	CP4e Error (% span)	CP12 Error (% span)	Combined Error (% span)
-10	-0.0125	0.009	-0.003
2.5	-0.0188	-0.006	-0.025
15	-0.0188	-0.188	-0.206
27.5	-0.025	-0.188	-0.213
40	-0.0313	-0.188	-0.219

Table 1 – Temperature Errors, Stream 2 (06/10/2014 – 09/07/2015)

3.2 K-Factor Errors

Corrected k-factors shown in Table 2 for Stream 2 were used to recalculate the k-factor when the recorded frequency was in the appropriate range.

Certificate no: 9.8-11973	Incorrect		Corrected	
Flowrate (m3/h)	Frequency (Hz)	K-Factor (pls/m3)	Frequency (Hz)	K-Factor (pls/m3)
307.9	131.6	1538.96	134.8	1575.8
603.2	263.7	1574.09	263.7	1574.09
1522.6	665.4	1573.18	665.4	1573.18
3028.5	1324.9	1574.93	1324.9	1574.93
4501.8	1973.4	1578.06	1973.4	1578.06
5853.9	2563.4	1576.45	2563.4	1576.45

Table 2 – K-Factor Errors, Stream 2 (06/10/2014 – 21/07/2015)

3.3 Accounting for Missing data

During periods of missing data there is no recorded temperature, pressure or frequency; gas quality has been recorded throughout.

3.3.1 Temperature and Pressure Data

Temperature and pressure measurements from nearby offtake Dowlais (see Figure 1) during a known good period, September 2013 – July 2014, were compared with Dyffryn to see if there was any correlation. Good correlation between the two sites was observed with a bias of +1.98 bar and +1.94 °C at Dyffryn compared to Dowlais. Standard deviations of 0.73 bar and 0.54 °C for pressure and temperature respectively were observed.
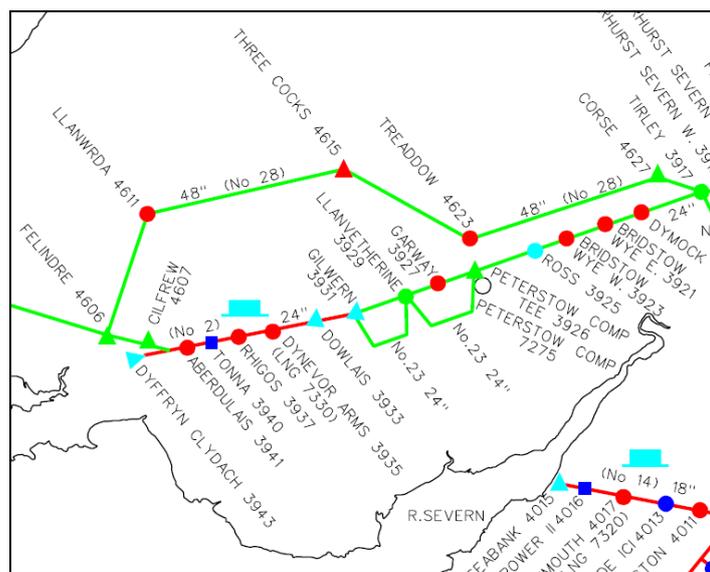

Figure 1 – Transmission Network Site Map

Missing pressure and temperature data was generated using Dowlais data over the same time period. Only data when both sites were flowing has been used. This data was taken to be the 'corrected' and therefore 'uncorrected' temperature measurements were calculated using the 'As Found' errors in Table 1 when the recorded measurement was in the appropriate range.

3.3.2 Meter Frequency Data

Meter frequency data over recorded periods, 23rd March – 12th May 2015 and 15th May – 28th July 2015, have been compared to frequency data over the previous year at Dyffryn to see if there was any correlation between when the frequency was in or out of the error range. Good correlation was seen, with small differences explained by varying temperature data.

Periods of known data were used to determine the relationship between amount of time the frequency is in the error range and the size of the volume error. The relationship was seen to be of the form y = -302.38x, where y is the volume error in standard m^3 and x is the time in error in hours.

Dyffryn meter frequency data from the previous year was analysed to determine the amount of time the frequency was in error over each month. This was used to calculate the average daily volume error due to the k-factor error for each month.

The density, flow rate and daily volumes have been recalculated from uncorrected and corrected temperature and k-factor readings. The error was calculated on a daily basis as the difference between volume totals using measured/uncorrected and corrected inputs.

The overall error is an over-registration of 0.1929%. The error is equivalent to 4.37 GWh.

4. CAUSES

Pressure ADC and temperature ADC checks failed during routine validation for Stream 1 and Temperature ADC checks failed for Stream 2. It was discovered that k-factors for Stream 2 had been incorrectly calculated at the certificating office during commissioning.

5. RECOMMENDATIONS AND LEARNING

ADC failures of this type will occur occasionally, if the same checks fail regularly then it suggests a fundamental problem with the equipment being tested and repairs or replacements should be made.

The start and end of the error are known, however, due to the high amount of uncertainty with missing data, the total error to be reconciled has been halved in accordance with the Offtake Arrangements Document. Appendix A shows the daily correction factors, which have already been halved between 6th October 2014 and 27th July 2015.

REFERENCES

Dyffryn_Data.xlsx – calculation spreadsheet

Dyffryn_Summary.xlsx – results spreadsheet

VERSION HISTORY

Version	Changes	Author	Date
O	Original	H Richardson	19/05/2016

DISTRIBUTION

Wales and West Utilities

APPENDIX A – Daily Correction Factors

The table below gives the daily correction factors which should be used to reconcile the error.

* Where there is a short period of missing data a correction has been applied equal to the mean correction factor for the previous and subsequent days.

Gas Day	Daily Correction Factor	Gas Day	Daily Correction Factor
06/10/2014	0.997805	11/11/2014	0.999716
07/10/2014	0.997962	12/11/2014	0.999715
08/10/2014	0.998052	13/11/2014	0.999723
09/10/2014	0.998095	14/11/2014	0.999717
10/10/2014	0.997983	15/11/2014	0.999724
11/10/2014	0.998038	16/11/2014	0.999721
12/10/2014	0.998083	17/11/2014	0.999727
13/10/2014	0.998376	18/11/2014	0.999722
14/10/2014	0.998176	19/11/2014	0.999721
15/10/2014	0.998162	20/11/2014	0.999724
16/10/2014	0.997939	21/11/2014	0.999726
17/10/2014	0.997640	22/11/2014	0.999711
18/10/2014	0.997601	23/11/2014	0.999734
19/10/2014	0.997611	24/11/2014	0.999751
20/10/2014	0.997986	25/11/2014	0.999749
21/10/2014	0.998189	26/11/2014	0.999743
22/10/2014	0.998354	27/11/2014	0.999740
23/10/2014	0.998198	28/11/2014	0.999731
24/10/2014	0.997952	29/11/2014	0.999728
25/10/2014	0.998178	30/11/2014	0.999733
26/10/2014	0.998065	01/12/2014	0.999783
27/10/2014	0.997991	02/12/2014	0.999786
28/10/2014	0.997798	03/12/2014	0.999794
29/10/2014	0.998153	04/12/2014	0.999802
30/10/2014	0.997905	05/12/2014	0.999786
31/10/2014	0.997505	06/12/2014	0.999790
01/11/2014	0.999691	07/12/2014	0.999793
02/11/2014	0.999687	08/12/2014	0.999796
03/11/2014	0.999705	09/12/2014	0.999808
04/11/2014	0.999714	10/12/2014	0.999802
05/11/2014	0.999714	11/12/2014	0.999803
06/11/2014	0.999708	12/12/2014	0.999803
07/11/2014	0.999710	13/12/2014	0.999805
08/11/2014	0.999717	14/12/2014	0.999812
09/11/2014	0.999729	15/12/2014	0.999805
10/11/2014	0.999730	16/12/2014	0.999807

Gas Day	Daily Correction Factor	Gas Day	Daily Correction Factor
17/12/2014	0.999803	31/01/2015	0.999859
18/12/2014	0.999799	01/02/2015	0.999851
19/12/2014	0.999809	02/02/2015	0.999849
20/12/2014	0.999810	03/02/2015	0.999850
21/12/2014	0.999803	04/02/2015	0.999854
22/12/2014	0.999805	05/02/2015	0.999844
23/12/2014	0.999799	06/02/2015	0.999856
24/12/2014	0.999800	07/02/2015	0.999857
25/12/2014	0.999805	08/02/2015	0.999852
26/12/2014	0.999811	09/02/2015	0.999850
27/12/2014	0.999818	10/02/2015	0.999855
28/12/2014	0.999809	11/02/2015	0.999859
29/12/2014	0.999828	12/02/2015	0.999858
30/12/2014	0.999826	13/02/2015	0.999852
31/12/2014	0.999812	14/02/2015	0.999853
01/01/2015	0.999812	15/02/2015	0.999852
02/01/2015	0.999826	16/02/2015	0.999855
03/01/2015	0.999826	17/02/2015	0.999851
04/01/2015	0.999825	18/02/2015	0.999852
05/01/2015	0.999834	19/02/2015	0.999850
06/01/2015	0.999834	20/02/2015	0.999852
07/01/2015	0.999843	21/02/2015	0.999851
08/01/2015	0.999847	22/02/2015	0.999854
09/01/2015	0.999830	23/02/2015	0.999854
10/01/2015	0.999825	24/02/2015	0.999851
11/01/2015	0.999834	25/02/2015	0.999843
12/01/2015	0.999833	26/02/2015	0.999843
13/01/2015	0.999833	27/02/2015	0.999849
14/01/2015	0.999836	28/02/2015	0.999841
15/01/2015	0.999846	01/03/2015	0.999750
16/01/2015	0.999840	02/03/2015	0.999759
17/01/2015	0.999838	03/03/2015	0.999758
18/01/2015	0.999844	04/03/2015	0.999766
19/01/2015	0.999849	05/03/2015	0.999764
20/01/2015	0.999848	06/03/2015	0.999735
21/01/2015	0.999846	07/03/2015	0.999735
22/01/2015	0.999844	08/03/2015	0.999740
23/01/2015	0.999847	09/03/2015	0.999767
24/01/2015	0.999847	10/03/2015	0.999743
25/01/2015	0.999844	11/03/2015	0.999751
26/01/2015	0.999845	12/03/2015	0.999743
27/01/2015	0.999849	13/03/2015	0.999765
28/01/2015	0.999848	14/03/2015	0.999757
29/01/2015	0.999854	15/03/2015	0.999755
30/01/2015	0.999858	16/03/2015	0.999761

Gas Day	Daily Correction Factor	Gas Day	Daily Correction Factor
17/03/2015	0.999747	01/05/2015	0.999420
18/03/2015	0.999741	02/05/2015	0.999802
19/03/2015	0.999738	03/05/2015	0.999772
20/03/2015	0.999735	04/05/2015	0.998786
21/03/2015	0.999714	05/05/2015	0.999124
22/03/2015	0.999731	06/05/2015	0.999121
23/03/2015	0.999748	07/05/2015	0.999358
24/03/2015	0.999858	08/05/2015	0.998606
25/03/2015	0.999858	09/05/2015	0.998518
26/03/2015	0.999853	10/05/2015	0.998476
27/03/2015	0.999867	11/05/2015	0.999739
28/03/2015	0.999859	12/05/2015	0.998418*
29/03/2015	0.999857	13/05/2015	0.998418*
30/03/2015	0.999862	14/05/2015	0.998418*
31/03/2015	0.999853	15/05/2015	0.998418*
01/04/2015	0.999860	16/05/2015	0.996459
02/04/2015	0.999857	17/05/2015	0.998997
03/04/2015	0.999836	18/05/2015	0.999801
04/04/2015	0.999613	19/05/2015	0.999307
05/04/2015	0.999369	20/05/2015	0.998976
06/04/2015	0.998463	21/05/2015	0.998634
07/04/2015	0.997864	22/05/2015	0.998571
08/04/2015	0.998013	23/05/2015	0.996107
09/04/2015	0.997175	24/05/2015	0.996280
10/04/2015	0.997369	25/05/2015	0.997113
11/04/2015	0.998641	26/05/2015	0.996178
12/04/2015	0.999856	27/05/2015	0.998407
13/04/2015	0.999352	28/05/2015	0.999010
14/04/2015	0.999194	29/05/2015	0.998333
15/04/2015	0.998625	30/05/2015	0.997989
16/04/2015	0.997436	31/05/2015	0.998859
17/04/2015	0.997455	01/06/2015	0.999053
18/04/2015	0.997199	02/06/2015	0.999268
19/04/2015	0.996996	03/06/2015	0.997862
20/04/2015	0.998257	04/06/2015	0.995851
21/04/2015	0.995159	05/06/2015	0.996878
22/04/2015	0.993776	06/06/2015	0.997020
23/04/2015	0.994614	07/06/2015	0.996583
24/04/2015	0.997479	08/06/2015	0.995966
25/04/2015	0.998427	09/06/2015	0.997057
26/04/2015	0.997862	10/06/2015	0.996138
27/04/2015	0.998859	11/06/2015	0.994059
28/04/2015	0.998259	12/06/2015	0.992674
29/04/2015	0.997685	13/06/2015	0.994360
30/04/2015	0.999462	14/06/2015	0.995349

Gas Day	Daily Correction Factor
15/06/2015	0.995011
16/06/2015	0.993335
17/06/2015	0.994876
18/06/2015	0.994350
19/06/2015	0.993170
20/06/2015	0.991696
21/06/2015	0.994839
22/06/2015	0.993703
23/06/2015	0.993815
24/06/2015	0.993914
25/06/2015	0.992968
26/06/2015	0.993545
27/06/2015	0.991336
28/06/2015	0.993936
29/06/2015	0.993130
30/06/2015	0.991826
01/07/2015	0.990989
02/07/2015	0.993887
03/07/2015	0.991410
04/07/2015	0.991449
05/07/2015	0.991492
06/07/2015	0.993637
07/07/2015	0.993564
08/07/2015	0.994072
09/07/2015	0.994159
10/07/2015	0.991700
11/07/2015	0.992420
12/07/2015	0.993523
13/07/2015	0.995066
14/07/2015	0.993276
15/07/2015	0.993870
16/07/2015	0.993431
17/07/2015	0.992379
18/07/2015	0.992348
19/07/2015	0.992453
20/07/2015	0.993364
21/07/2015	0.996571
22/07/2015	1.000000
23/07/2015	1.000000
24/07/2015	1.000000
25/07/2015	1.000000
26/07/2015	1.000000
27/07/2015	1.000000