Measurement Error Report

Severn Trent Water Limited

MER WM018 Strongford BNEF

Document Reference: NK3225A-001

Client Reference: NK3225A

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1 Revision Control

Rev	Issue date	Description	Prep.	App.
1	11/01/2022	Issued for comment	BK	PE

2 Executive Summary

Site Name	Strongford BNEF
DNO	Cadent Gas Limited
LDZ	West Midlands
Error Start Date	28th July 2020
(Or) Last Good Date	
Error Corrected Date	17th November 2021
Size of Error (over or under read)	23,989 Sm^3 under-registration (approximately 0.233 GWh)
Error Description	Intermittent erroneous USM flow readings
Methodology	Comparison of inlet meter and fiscal meter flow readings
Meter Type	Ultrasonic meter
MER Unique Reference Number	WM018
Cadent Internal Reference	MER/CAD/202/20

3 Error Description

Strongford BNEF has a single 2" Sick Flowsic500 ultrasonic meter stream for measurement of gas exiting the grid entry unit (GEU) and entering the distribution network (referred to in this report as 'Fiscal USM'). A second 2" Sick Flowsic500 ultrasonic meter is located on the inlet to the GEU for process control (referred to in this report as 'Inlet USM'). Propane injection is used to control the gas properties (e.g. calorific value, Wobbe number, etc.) to meet the requirements of the Gas Safety (Management) Regulations (GS(M)R). Gas that is not within specification is rejected by a diverter valve.

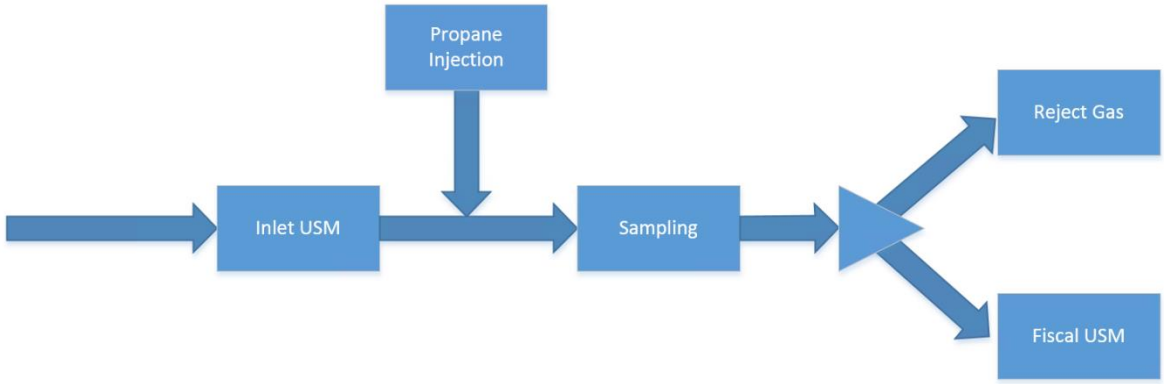

Figure 1 - Grid Entry Unit Flow Diagram

During normal operation the Fiscal USM will read slightly higher (~15 Sm3/h) than the Inlet USM due to the addition of propane. On many occasions between 28th July 2020 and 28th June 2021 the Fiscal USM intermittently read much higher or lower than the Inlet USM for prolonged periods of time. The individual descriptions of each error period are contained in Appendix C. This error was first detected 17th October 2018 and was found to have started on 11th October 2017, when the diverter valve was set to reject, however the Fiscal USM continued to register a flow. The cause of error was considered to be rectified and measurement error report (WM016) produced, until similar errors occurred on 28th July 2020 and therefore a further investigation was considered necessary.

4 Methodology

The offset between the Inlet USM and Fiscal USM during normal operation was calculated from the periods of normal operation surrounding each error period (refer to Appendix B). The Fiscal USM volume flow was then corrected (on ~10 second basis) using the Inlet USM volume flow plus the offset for that period. Two sets of volume totals were calculated; one using the measured Fiscal USM flow and another using the corrected Fiscal USM flow, the error being the difference between the two.

5 Error Quantification

The error is estimated to be an overall under-registration of 23,989 Sm^3. The error for each period is detailed in Table 1. The error should be corrected using the daily correction factors in Appendix A.

Error Period	Date	Total Error Sm^3
1	28th July 2020	+166.08
2	9th August 2020	+425.43
3	30th September to 1st October 2020[1]	-2465.45
4	28th November to 1st December 2020	-8,160.51
5	8th to 9th December 2020	+192.56
6	9th December 2020	-610.70
7	11th December 2020	-477.59
8	13th December 2020	+1312.54
9	21st December 2020	-2,735.43
10	25th to 26th December2020	-1,492.64
11	2nd to 5th January 2021	-11,507.25
12	29th January to 1st February 2021	-12,031.13
13	5th to 6th February 2021	+814.51
14	12th to 15th February 2021	-9,191.95
15	2nd March 2021	+295.94
16	10th to 11th March 2021	+7,421.81
17	16th March 2021	+916.24
18	25th to 26th March 2021	-2,321.56
19	27th to 28th March 2021	-2,490.67
20	29th March 2021	+359.30
21	30th to 31st March 2021	+307.89
22	31st March 2021	+299.59
23	1st to 4th April 2021	+11,451.46
24	12th April 2021	-1,411.17

[1] Inlet USM data missing for this period, therefore no offset could be determined. Corrected flow rate was determined averaging Fiscal USM flow rates from before and after the error and the error quantified as the difference of the two.

Error Period	Date	Total Error Sm^3
25	14th to 15th April 2021[2]	-16.68
26	19th April 2021	-78.98
27	12th May 2021	+203.74
28	7th June 2021	-26.59
29	13th to 14th June 2021	+2,364.03
30	16th June 2021	+15.74
31	21st June 2021	+223.92
32	22nd June 2021	+41.30
33	27th to 28th June 2021	-80.73
34	1st July 2021	+96.02
35	5th July 2021	+204.65
36	12th July 2021	+362.04
37	22nd July 2021	+1,377.02
38	23rd July 2021	+170.08
39	19th August 2021	+223.46
40	9th September 2021	+279.00
41	2nd October 2021	+492.44
42	21st October 2021	+244.14
43	27th to 28th October 2021	+849.40
	Total	-23,988.69

Table 1 – Error Quantification

6 Learning

It is suspected that contamination on the ultrasonic meter transducers originating from the propane injection system has caused the meter to read erroneously. Training has been provided on how to clean the meter, an additional filtration system was installed, and the pipework was cleaned on 17th November 2021 to prevent the issue from reoccurring.

7 References

Strongford Site Data Files (RD######.T0014; DAT$####.ST3)
Gemini Daily Volumes
MER_WM018_Strongford_Data.xlsx - Calculation Data spreadsheet

[2] Percentage error of daily volume for the 14th April (0.035%) does not meet the 0.1% reconcilable requirement and therefore is not included in the total error quantification. Thus, no correction factor is required.

8 Appendix A – Daily Correction Factors

The error should be corrected using the Daily Correction Factors applied to the Gemini Daily Volumes as detailed below.

Gas Day	Gemini Daily Volume (MSCM)	Daily Correction Factor
28-Jul-20	0.00297	0.944069
09-Aug-20	0.00436	0.902379
30 -Sep-20	0.00819	1.100431
01-Oct-20	0.00576	1.613008
28-Nov-20	0.00522	1.688151
29-Nov-20	0.00220	1.098454
30-Nov-20	0.00839	0.977063
01-Dec-20	0.00727	1.082713
08-Dec-20	0.00763	1.003502
09-Dec-20	0.00842	1.053542
11-Dec-20	0.00735	0.821316
12-Dec-20	0.00434	1.553789
13-Dec-20	0.00676	1.049424
21-Dec-20	0.00404	1.253725
22-Dec-20	0.00026	2.831485
25-Dec-20	0.00646	1.027197
26-Dec-20	0.00276	2.288624
01-Jan-21	0.00279	2.291787
02-Jan-21	0.00285	2.265385
03-Jan-21	0.00045	2.239047
04-Jan-21	0.00560	1.472842
05-Jan-21	0.00519	1.766008
29-Jan-21	0.00508	1.786341
30-Jan-21	0.00629	1.224623
31-Jan-21	0.00827	0.914688
01-Feb-21	0.00740	0.985226
05-Feb-21	0.00590	1.260949
06-Feb-21	0.00382	1.947131
12-Feb-21	0.00297	2.211547
13-Feb-21	0.00684	1.064417
14-Feb-21	0.00561	0.975709
15-Feb-21	0.00574	0.972181
01-Mar-21	0.01372	0.580462
02-Mar-21	0.00963	0.827093
10-Mar-21	0.00923	0.986741
11-Mar-21	0.00961	0.917405
15-Mar-21	0.00925	1.019019
16-Mar-21	0.00780	1.275099
25-Mar-21	0.00755	1.329720
26-Mar-21	0.01067	0.966318

Gas Day	Gemini Daily Volume (MSCM)	Daily Correction Factor
27-Mar-21	0.01069	0.971185
28-Mar-21	0.01057	0.971656
30-Mar-21	0.01238	0.841639
31-Mar-21	0.01430	0.731259
01-Apr-21	0.01432	0.731665
02-Apr-21	0.01214	0.851654
03-Apr-21	0.00850	1.022849
04-Apr-21	0.00594	1.204712
11-Apr-21	0.01037	1.000353
12-Apr-21	0.00653	1.002556
15-Apr-21	0.00549	1.009040
18-Apr-21	0.00960	0.978780
19-Apr-21	0.00067	1.040055
12-May-21	0.00832	0.859665
07-Jun-21	0.00321	0.626069
13-Jun-21	0.00892	0.998236
14-Jun-21	0.00865	0.974113
16-Jun-21	0.00931	0.995563
21-Jun-21	0.00492	1.016451
22-Jun-21	0.00199	0.951545
27-Jun-21	0.00804	0.974533
01-Jul-21	0.00768	0.952778
05-Jul-21	0.00991	0.861066
12-Jul-21	0.00858	0.980161
22-Jul-21	0.00785	0.971545
23-Jul-21	0.00433	0.935815
19-Aug-21	0.00635	0.922364
09-Sep-21	0.00940	0.974002
02-Oct-21	0.00953	0.963838
20-Oct-21	0.00944	0.946572
27-Oct-21	0.00297	0.944069
28-Oct-21	0.00436	0.902379

9 Appendix B – Table of Average Offsets

Error Period	Date	Average Offset Sm³
1	28th to 29th July 2020	+12.12
2	9th to 10th August 2020	+13.32
3	30th September to 2nd October 2020	N/A[3]
4	28th November to 2nd December 2020	+14.04
5	8th to 9th December 2020	+15.18
6	9th to 10th December 2020	+21.23
7	10th to 13th December 2020	+19.37
8	12th to 14th December 2020	+19.83
9	21st to 23rd December 2020	+12.50
10	25th to 27th December 2020	+11.84
11	1st to 6th January 2021	+12.58
12	29th January to 2nd February 2021	+16.59
13	5th to 7th February 2021	+13.24
14	12th to 16th February 2021	+14.30
15	1st to 3rd March 2021	+8.93
16	10th to 12th March 2021	+12.35
17	15th to 17th March 2021	+12.68
18	25th to 27th March 2021	+13.29
19	27th to 29th March 2021	+14.76
20	28th to 30th March 2021	+15.26
21	30th to 31st March 2021	+12.47
22	31st March to 1st April 2021	+11.09
23	1st to 5th April 2021	+15.47
24	11th to 13th April 2021	+18.97
25	14th to 16th April 2021	+23.75
26	18th to 20th April 2021	+14.01
27	12th to 13th May 2021	+25.25
28	7th to 8th June 2021	+10.47
29	13th to 15th June 2021	+13.93
30	16th to 17th June 2021	+13.19
31	21st to 22nd June 2021	+12.41
32	22nd to 23rd June 2021	+12.77
33	27th to 28th June 2021	+12.12
34	30th June to 3rd July 2021	+21.57
35	5th to 6th July 2021	+27.57
36	12th to 13th July 2021	+26.89
37	22nd July 2021	+33.68
38	23rd to 24th July 2021	+32.68

[3] Inlet USM data missing for this period, therefore no offset could be determined. Error was determined using Fiscal USM flow rates before and after error.

Error Period	Date	Average Offset Sm^3
39	19th to 20th August 2021	+16.31
40	9th to 10th September 2021	+13.41
41	2nd to 3rd October 2021	+13.81
42	20th to 22nd October 2021	+20.38
43	27th to 29th October 2021	+17.05

10 Appendix C – Error Period Descriptions

10.1 Error Period 1 – July 2020

At 10:20 on 28th July 2020, the Fiscal USM began to read ~163 Sm^3/h above the Inlet USM. The over registering continued until 11:26, at which point the Fiscal USM read an offset within the normal operating range again.

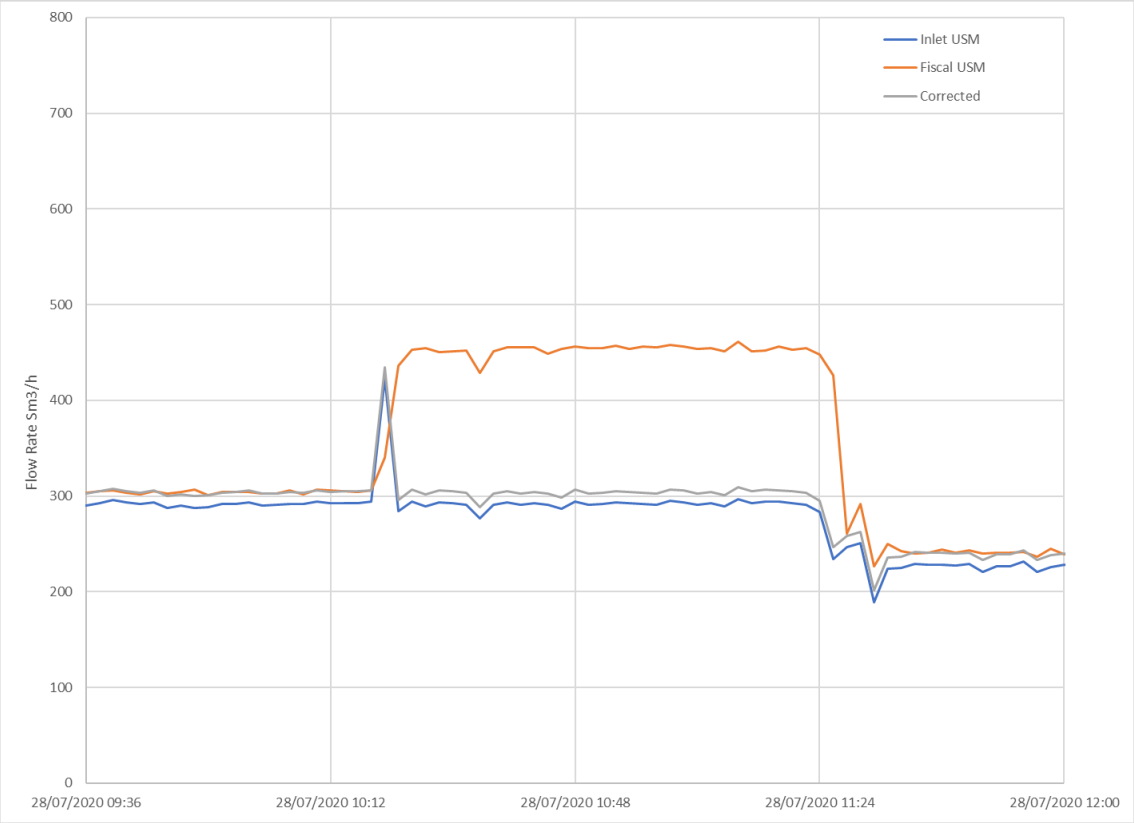

Figure 2. Error 1 Plot - July 2020

10.2 Error Period 2 – August 2020

At 09:30 on 9th August 2020, the process was halted with zero flow being registered on the Inlet USM. However, the Fiscal USM continued to produce a reading of ~128 Sm^3/h. The process restarted again at 12:10 with the flow diverted and the Fiscal USM still reading the same fixed flow rate as before. When the gas to grid valve was opened at 12:52, the Fiscal USM began reading correctly with an offset of ~13.2 Sm^3/h.

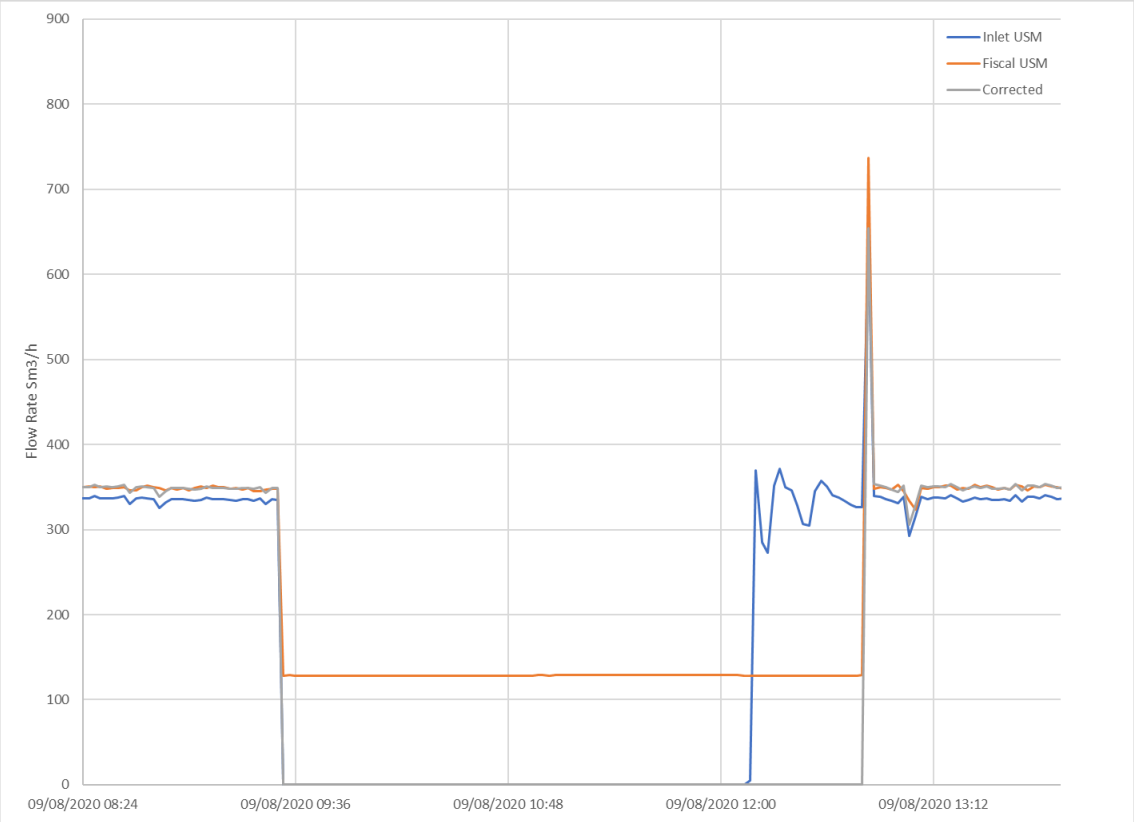

Figure 3. Error 2 Plot - August 2020

10.3 Error Period 3 – September to October 2020

At 19:17 on 30th September 2020, the Fiscal USM began under registering the flow by ~124 Sm^3/h. The under registering continued until the Fiscal USM read no flow at 15:47 on 1st October 2020. The Fiscal USM was operating correctly when it read a flow again at 17:23.

Inlet USM data is missing for this period, therefore no offset could be determined. Corrected flow rate was determined by averaging Fiscal USM flow rates from before and after the error and the error quantified as the difference of the two.

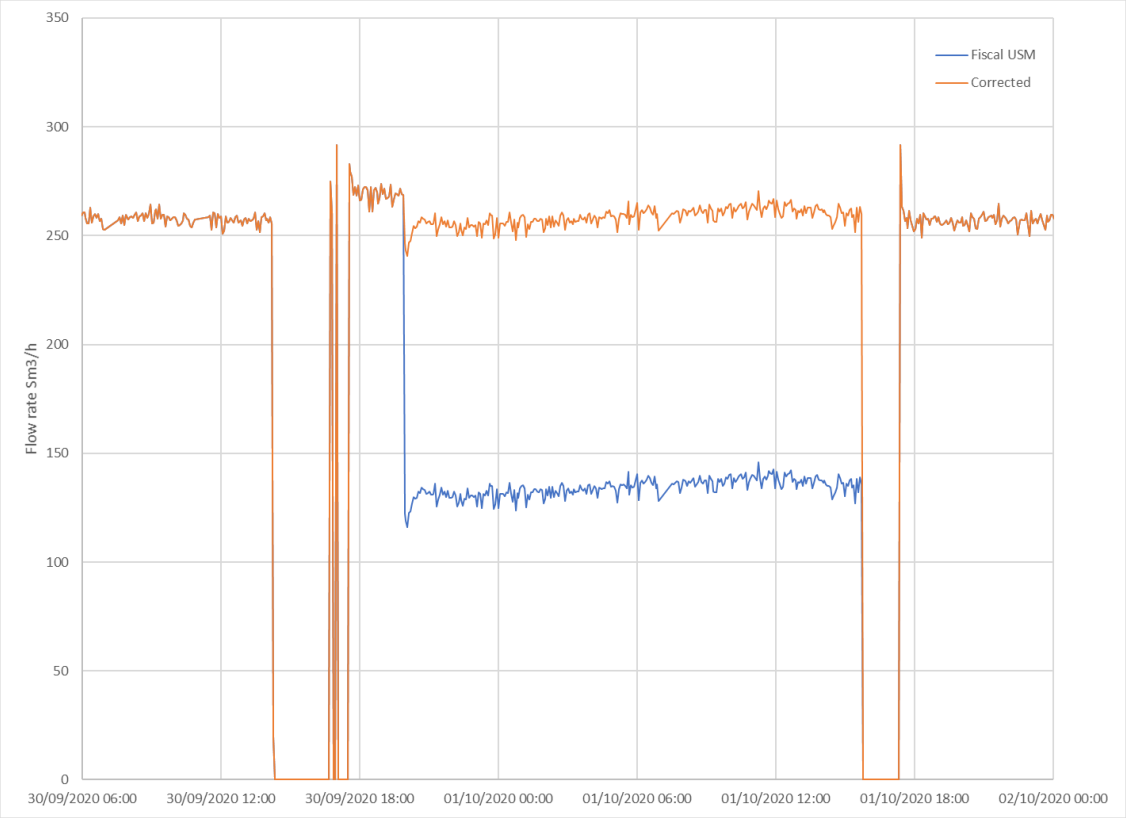

Figure 4. Error 3 Plot - September to October 2020

10.4 Error Period 4 – November 2020

At 23:24 on 29th November 2020, the Fiscal USM started to read ~133 Sm^3/h lower than the Inlet USM. The under reading continued until 09:05 on the 1st December 2020, when the process was briefly halted and restarted with the flow being diverted to reject. The process began to flow through the Fiscal USM at 10:20, however, the Fiscal USM began to read ~248 Sm^3/h below the Inlet USM. The process was then diverted to reject once more at 10:31. When the flow was re directed through the Fiscal USM at 10:38, it began to read an offset of ~186 Sm^3/h above the Inlet USM. The process was then stopped at 12:30, with the Fiscal USM continuing to produce a reading of ~133 Sm^3/h until 13:21 when there was no flow registered on both USMs.

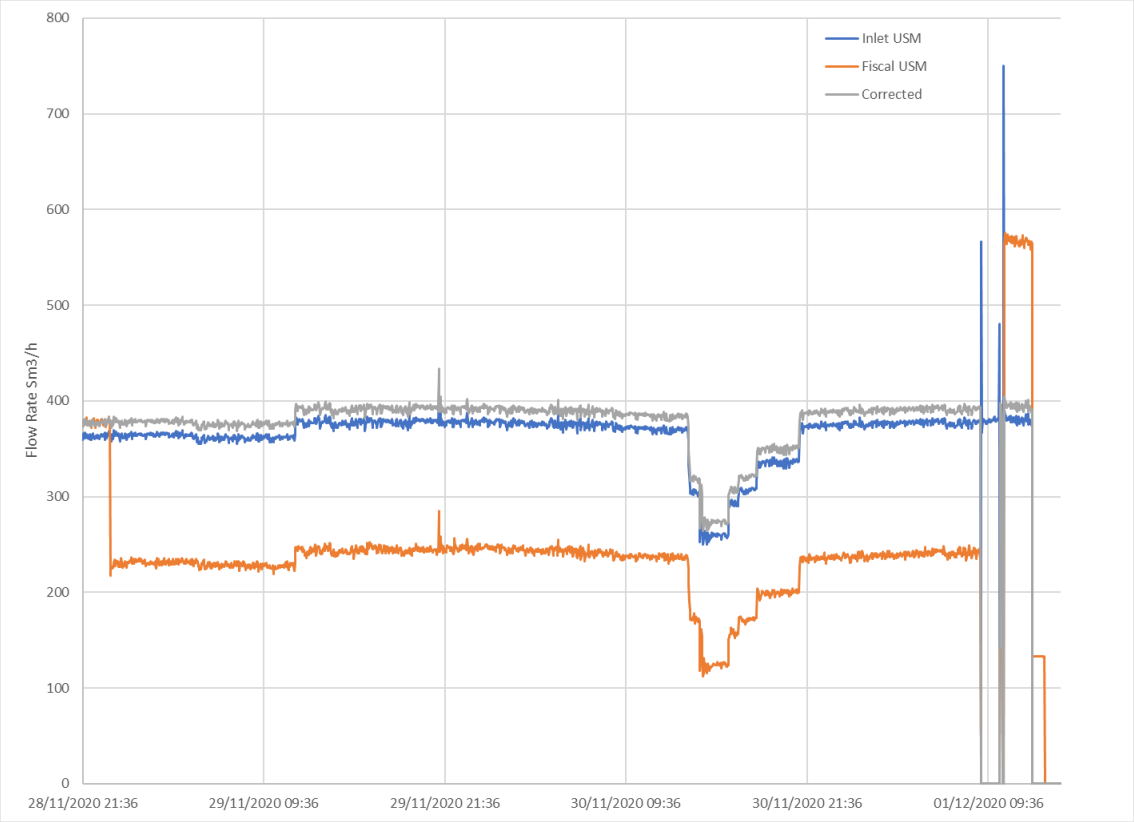

Figure 5. Error 4 Plot - November 2020

10.5 Error Period 5 – December 2020

At 17:56 on 8th December 2020, the Fiscal USM started to intermittently read short periods (1-2 minutes) of >160 Sm^3/h both lower and higher than the Inlet USM, until 20:30. At which time the Fiscal USM began reading ~185 Sm^3/h higher than the Inlet USM. The over reading continued until 21:39 when the Fiscal USM returned to a normal offset of ~21 Sm^3/h.

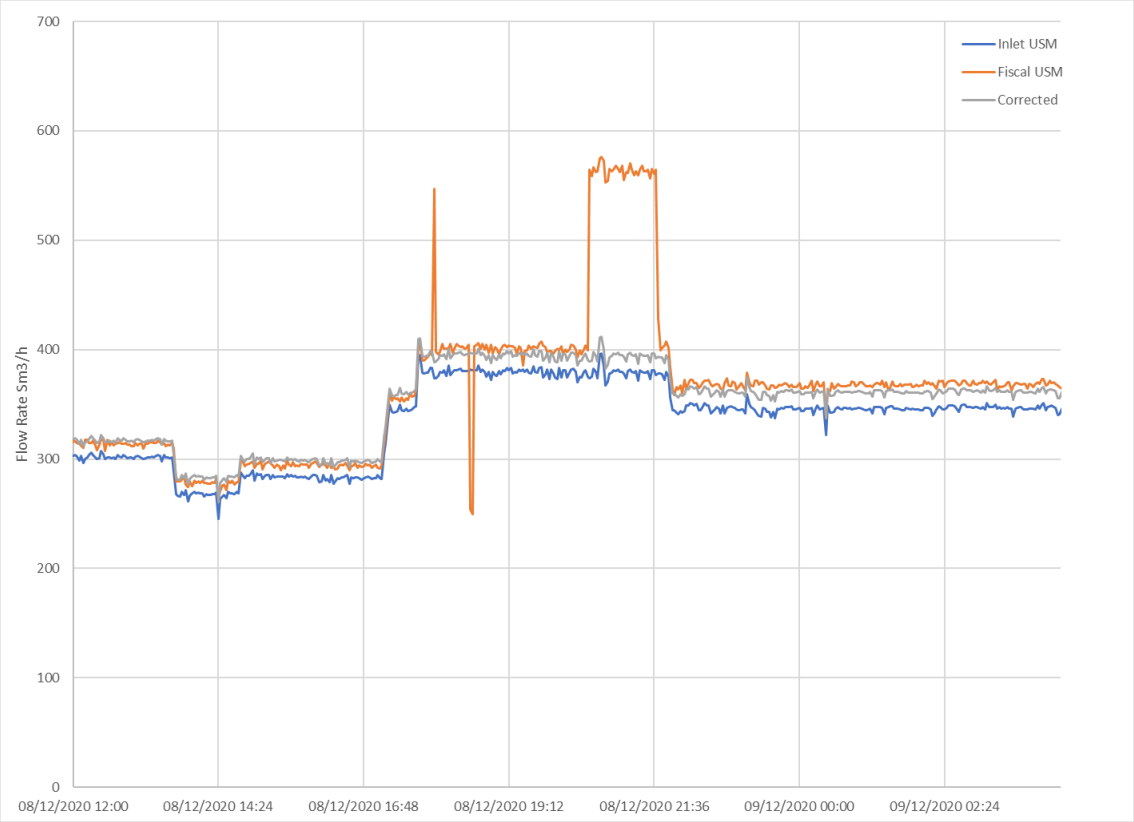

Figure 6. Error 5 Plot - December 2020

10.6 Error Period 6 – December 2020

At 16:53 on 9th December 2020 the Fiscal USM began to under register, ~138 Sm^3/h below the Inlet USM. This continues until 20:42 when the Fiscal USM returns to an expected offset of ~20 Sm^3/h.

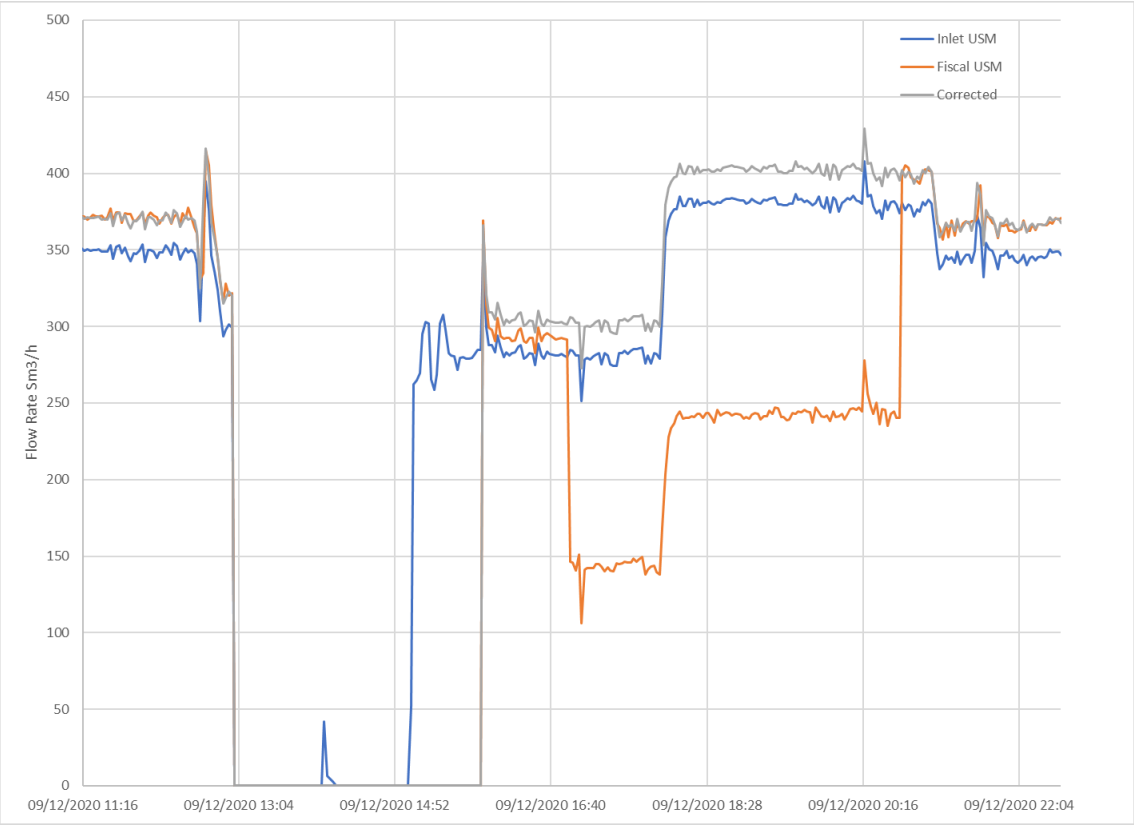

Figure 7. Error 6 Plot - December 2020

10.7 Error Period 7 – December 2020

At 13:07 on 11th December 2020 the process was stopped and restarted again at 15:21 with the flow diverted. At 15:47, when the grid valve was opened, the Fiscal USM under registered the flow. The under registering continued until 15:47, when the Fiscal USM began to read correctly. The Fiscal USM continued to produce a correct reading until 07:25 on 12th December 2020 when it begins to under read with an offset of ~128 Sm^3/h below the Inlet USM. At 10:28 the Fiscal USM returns to the correct offset.

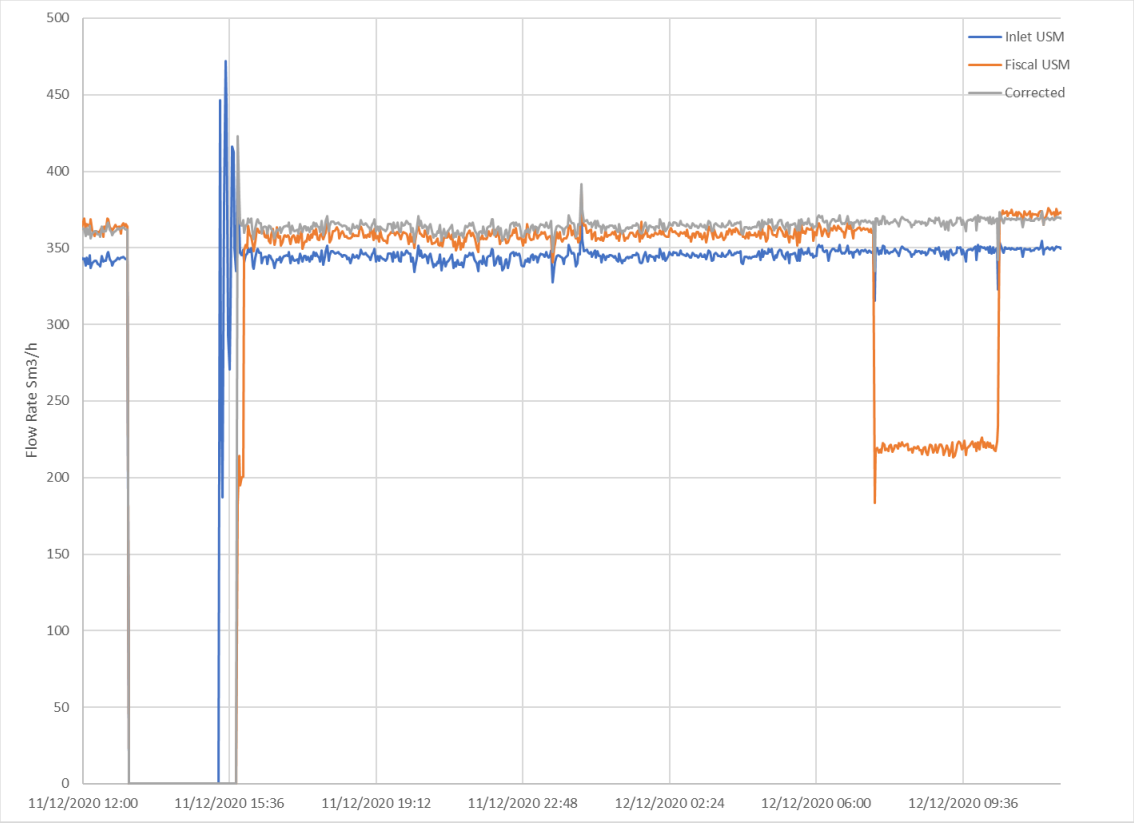

Figure 8. Error 7 Plot - December 2020

10.8 Error Period 8 – December 2020

At 06:55 on 13th December 2020 the Fiscal USM began reading ~182 Sm^3/h higher than the Inlet USM. The process was stopped at 12:35, at which point the Inlet USM did not measure any flow. However, the Fiscal USM registered a flow of ~136 Sm^3/h. The process was then restarted at 15:10 with the gas diverted, but the Fiscal USM continued to read ~136 Sm^3/h until 15:32, when it began to measure the correct flow once the grid valve was opened. Shortly after, at 15:49 the Fiscal USM read below the Inlet USM (~42-133 Sm^3/h) for one minute before returning to registering the correct flow, with an offset of ~16 Sm^3/h above the Inlet USM.

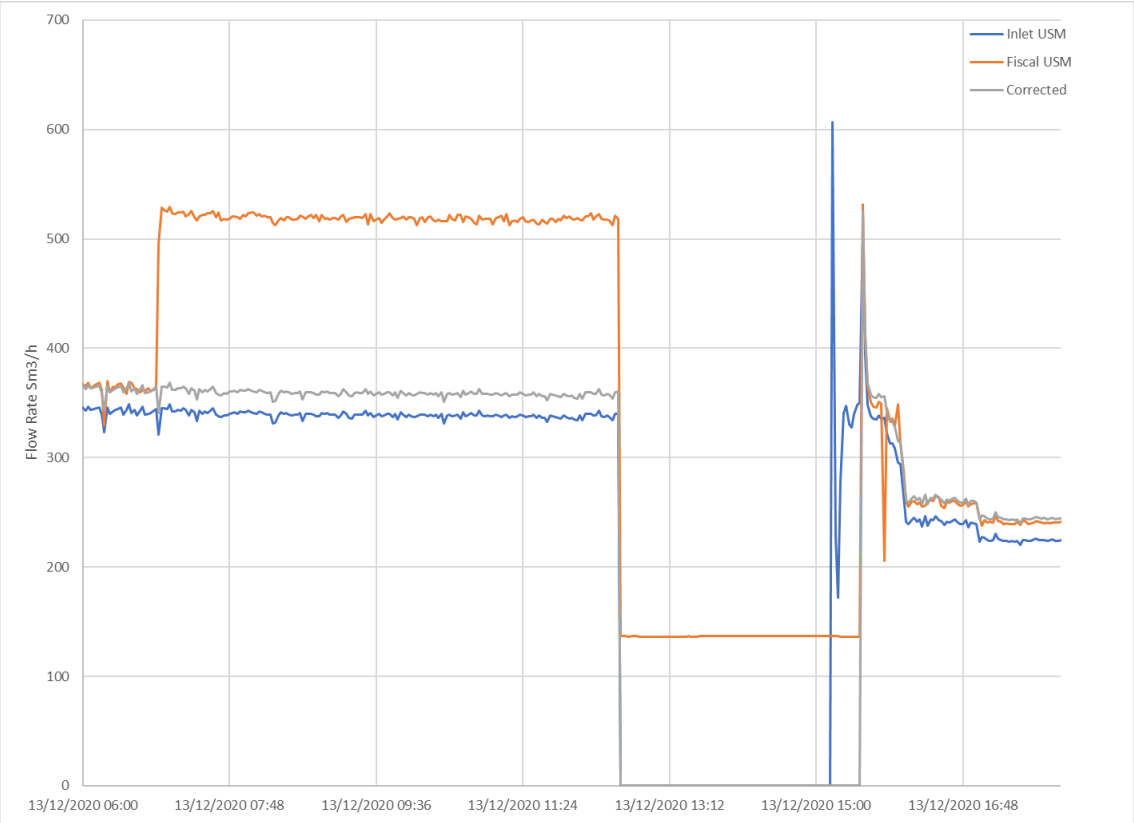

Figure 9. Error 8 Plot - December 2020

10.9 Error Period 9 – December 2020

At 12:05 on 21st December 2020 the Fiscal USM began to read ~129 Sm^3/h below the Inlet USM. The under reading continued until 07:21 on 22nd December 2020 when the Fiscal USM began registering the correct flow with an offset of ~12.5 Sm^3/h above the Inlet USM.

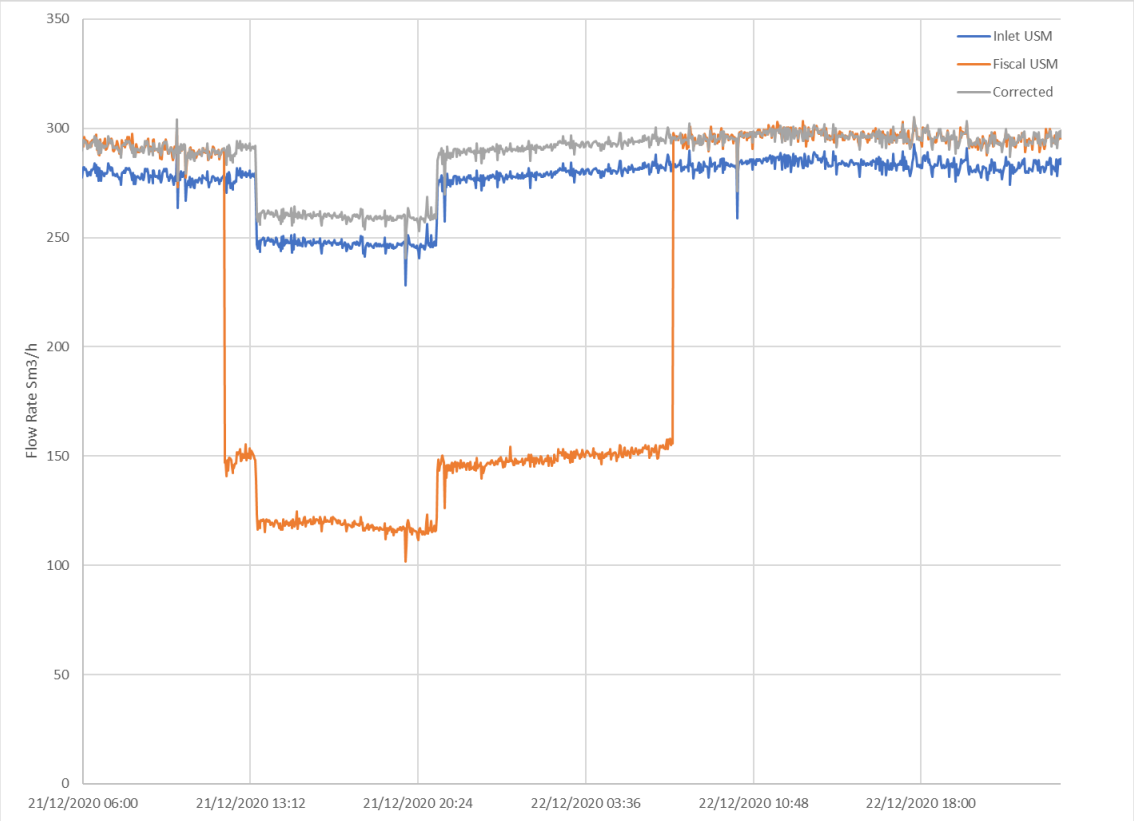

Figure 10. Error 9 Plot - December 2020

10.10 Error Period 10 – December 2020

At 22:26 on 25th December 2020, the Fiscal USM began reading ~143 Sm^3/h below the Inlet USM reading. This under reading continued until the process was stopped at 08:01 on 26th December 2020.

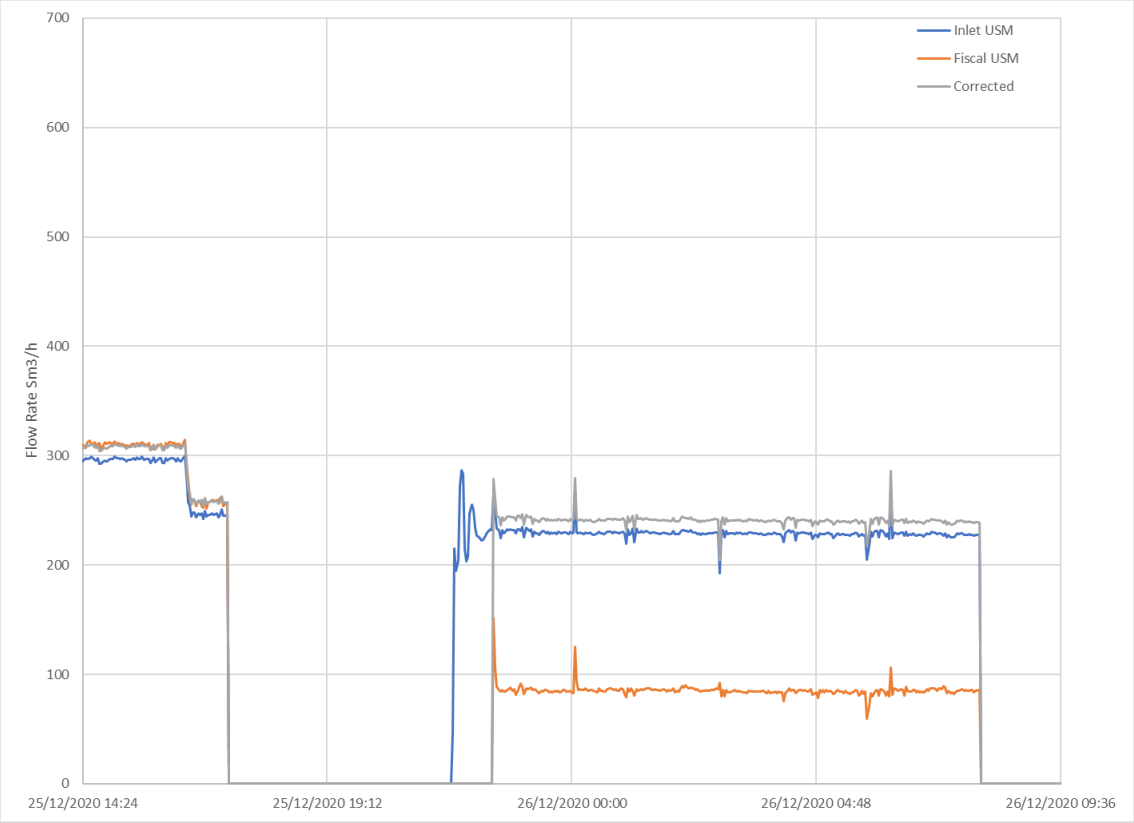

Figure 11. Error 10 Plot - December 2020

10.11 Error Period 11 – January 2021

At 03:50 on 2nd January 2021 the Fiscal USM began reading ~136 Sm^3/h below the Inlet USM reading. This under reading continued until the process was stopped at 08:42 on 5th January 2021.

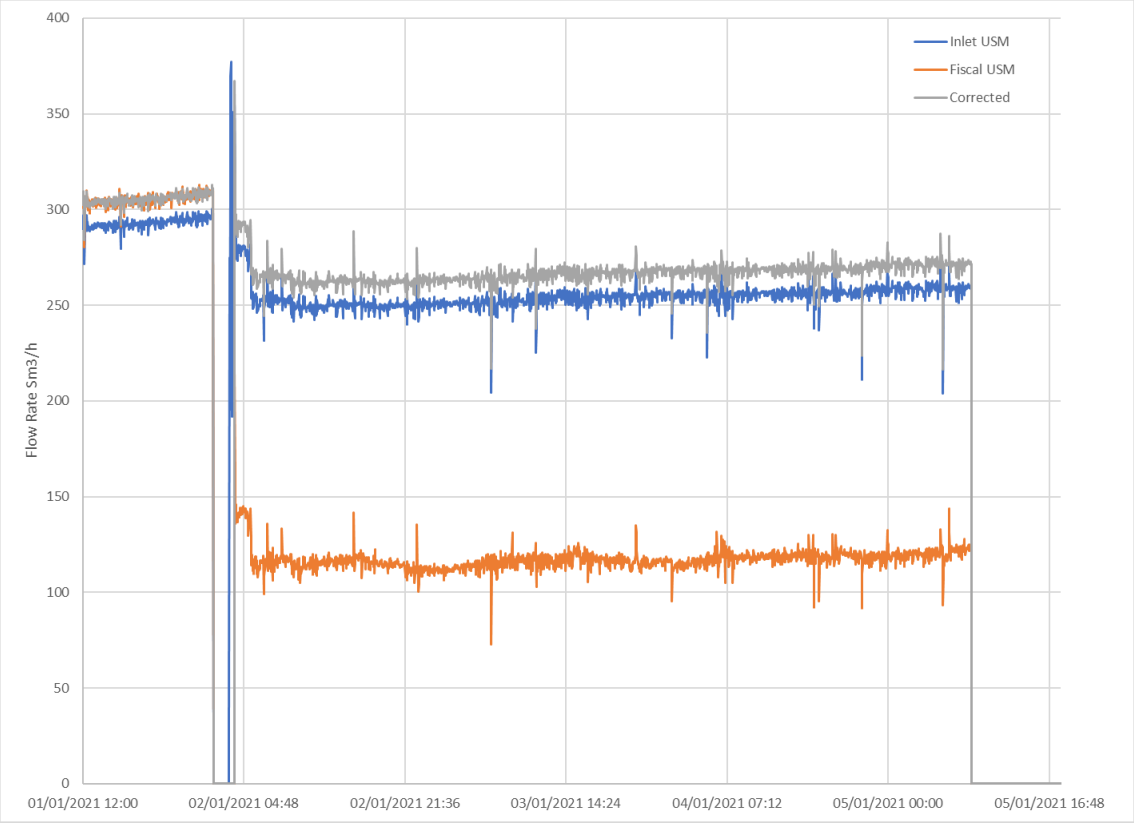

Figure 12. Error 11 Plot - January 2021

10.12 Error Period 12 – January to February 2021

At 14:05 on 29th January 2021 the Fiscal USM began reading ~140 Sm^3/h below the Inlet USM reading. This under reading continued until the process was diverted again at 11:50 on 1st February 2021. The under reading continued until 16:49, when the Fiscal USM began reading the correct flow rate.

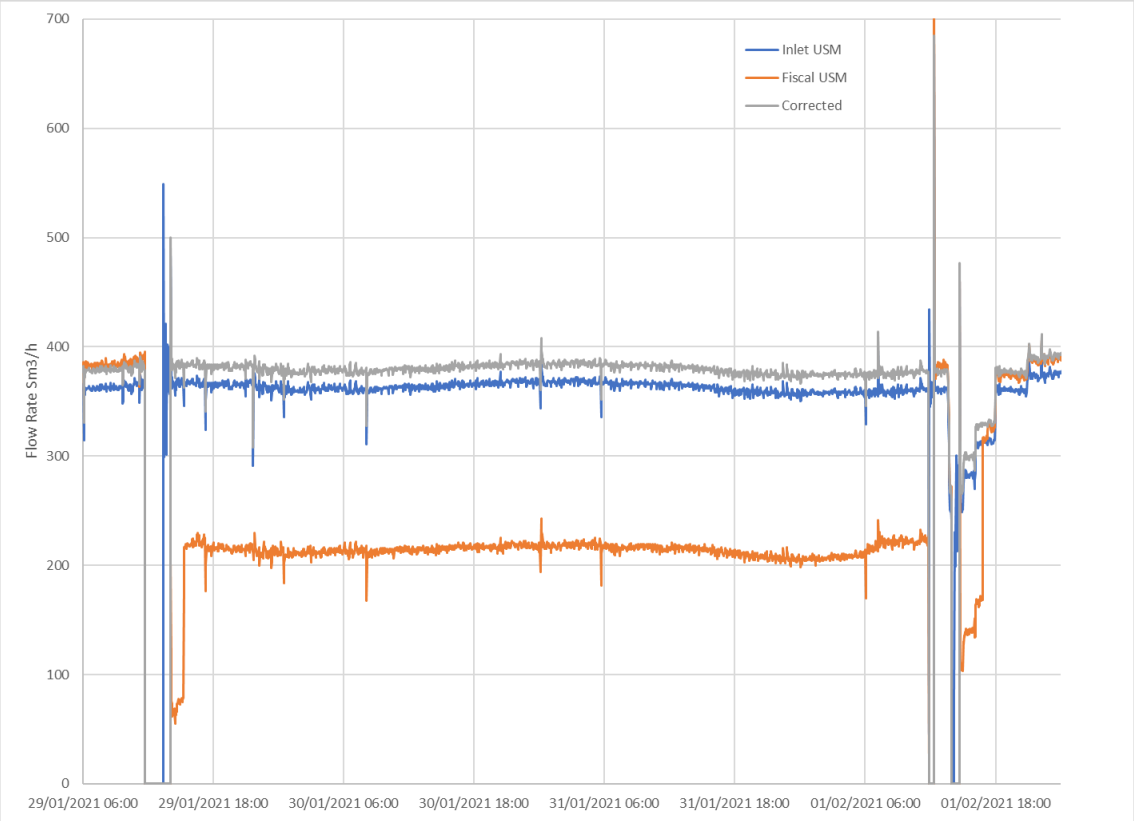

Figure 13. Error 12 Plot – January to February 2021

10.13 Error Period 13 – February 2021

At 23:56 on 5th February 2021, the process was halted with zero flow being registered on the Inlet USM. However, the Fiscal USM continued to produce a reading of ~140 Sm^3/h. The process restarted again at 05:13 on 6th February 2021 with the gas diverted, however the Fiscal USM continued to read the same fixed flow rate. The Fiscal USM began reading correctly at 06:51.

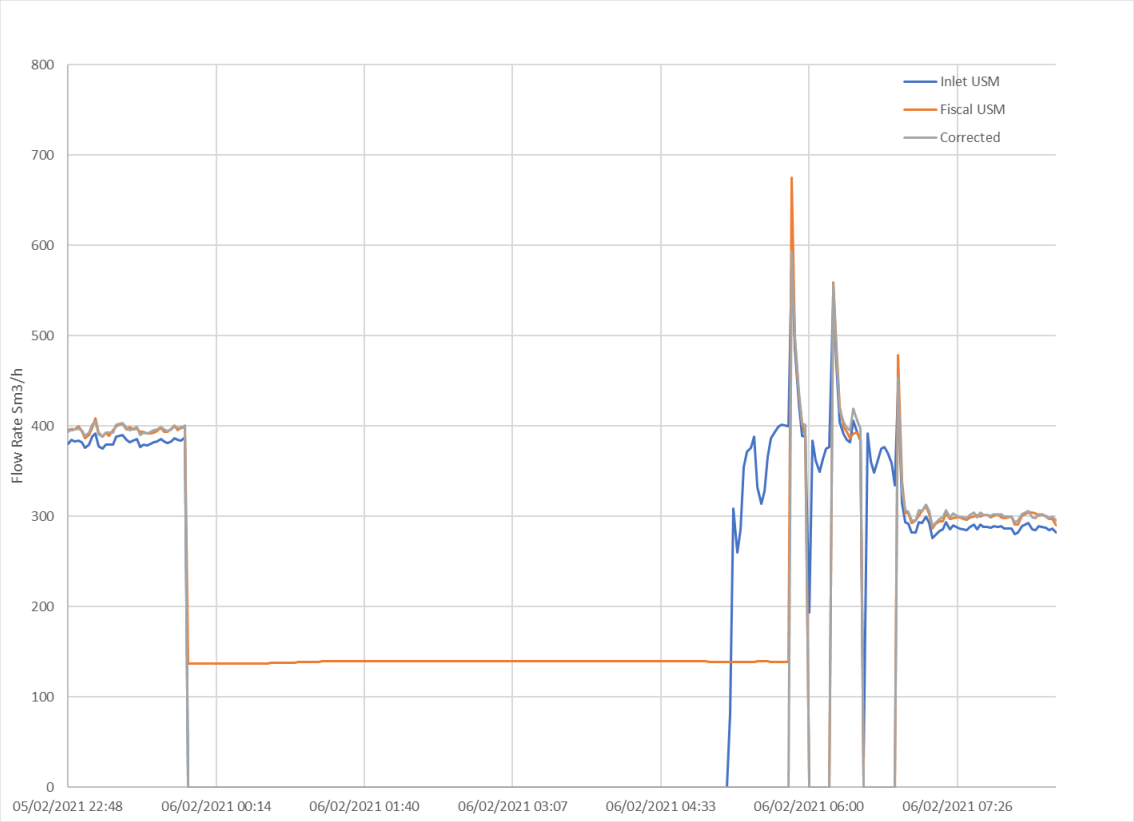

Figure 14. Error 13 Plot - February 2021

10.14 Error Period 14 – February 2021

At 18:52 on 12th February 2021, the Fiscal USM began to read ~137 Sm^3/h below the Inlet USM reading. The under registering continued until 12:44 on 15th February 2021, when the Fiscal USM began reading a flow rate ~178 Sm^3/h above the Inlet USM for 30 minutes. The Fiscal USM began reading a flow with an offset within the normal operating range (~16.6 Sm^3/h) at 14:07.

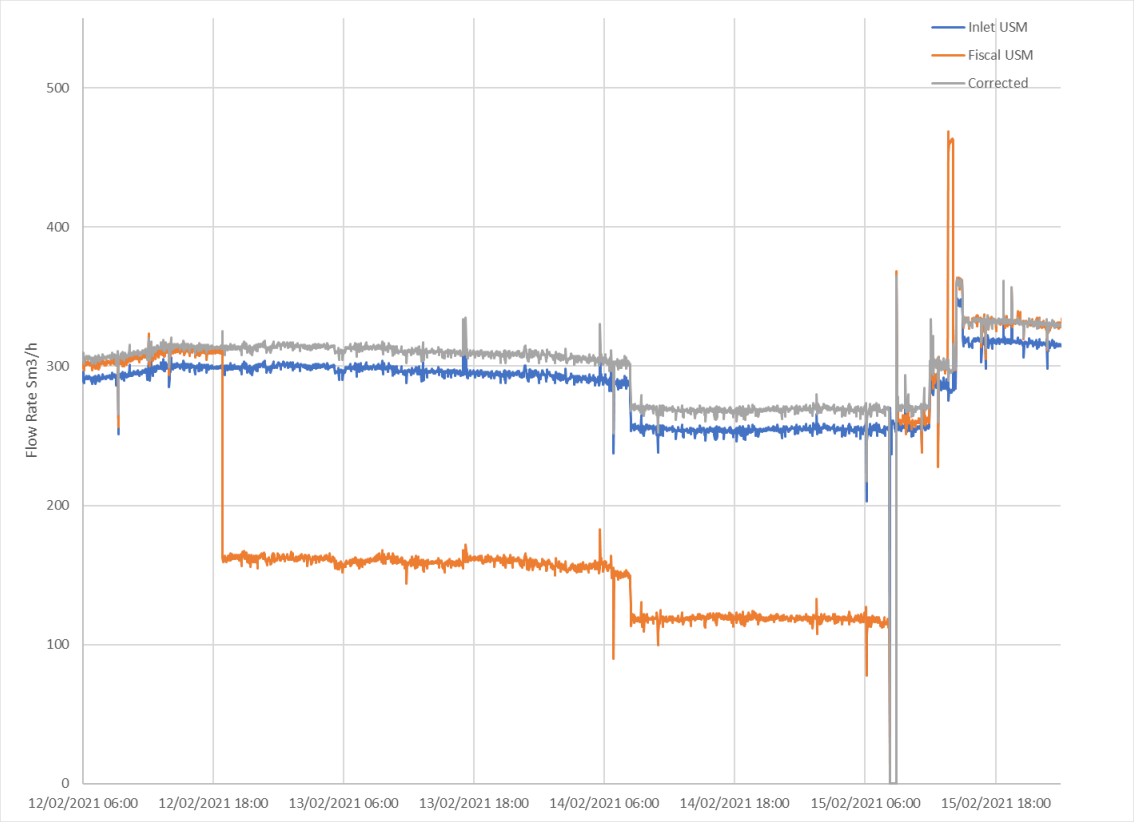

Figure 15. Error 14 Plot - February 2021

10.15 Error Period 15 – March 2021

At 04:20 on 2nd March 2021, the process was stopped with zero flow being registered on the Inlet USM. However, the Fiscal USM continued to produce a reading of ~140 Sm^3/h. The process restarted again at 05:35 with the gas diverted, however the Fiscal USM continued to read the same fixed flow rate. When the gas to grid valve was opened at 06:06, the Fiscal USM began reading correctly.

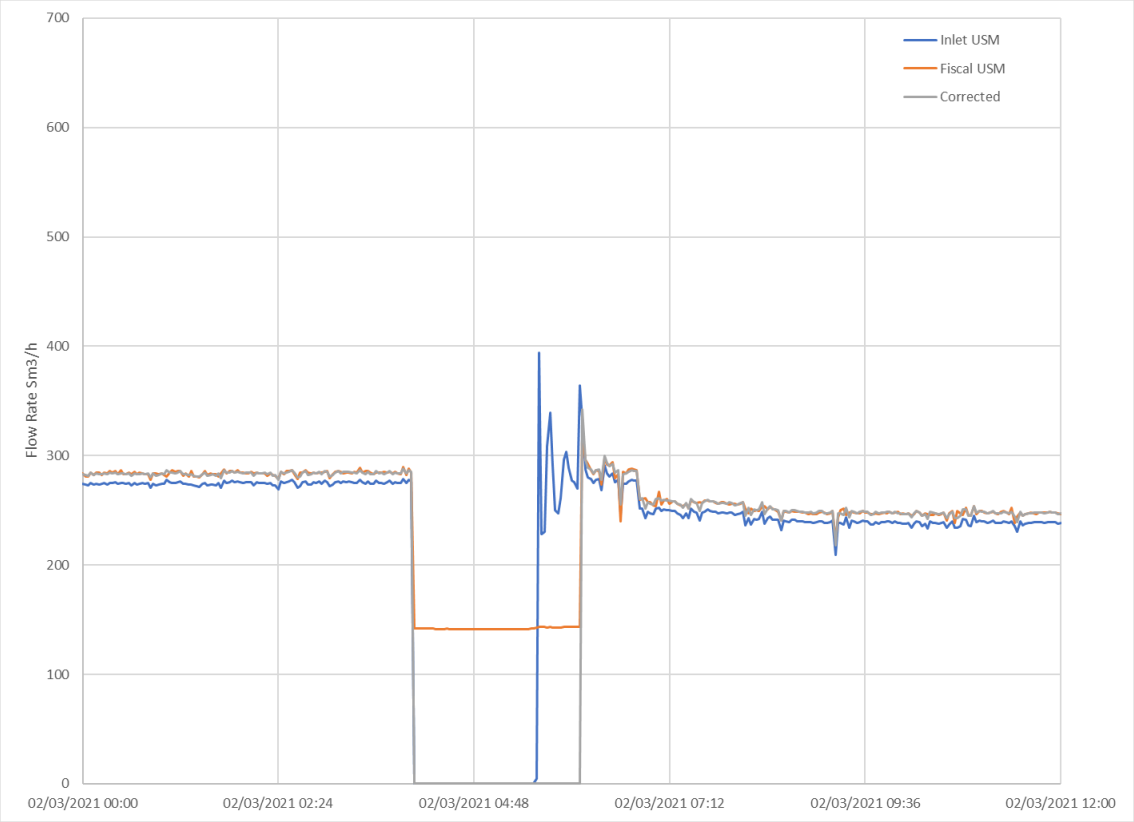

Figure 16. Error 15 Plot - March 2021

10.16 Error Period 16 – March 2021

The process was stopped at 10:29 on 10th March 2021. It was restarted by diverting the flow away from the Fiscal USM at 11:36. Once the process had stabilised, it was the gas to grid valve was opened and the Fiscal USM began measuring a flow correctly. The Fiscal USM's reading began fluctuating above and below the Inlet USM until 12:33 when it read ~196 Sm^3/h above the Inlet USM reading. This over reading continued until 13:22 when the Fiscal USM's offset from the Inlet USM increased again to ~370 Sm^3/h. This continued until the process was diverted again, at 09:43 on 11th March 2021. When the grid valve was opened for a short period at 11:42, the Fiscal USM under registered the flow before being diverted again. The Fiscal USM began operating correctly at 12:26, reading an offset of ~12.5 Sm^3/h.

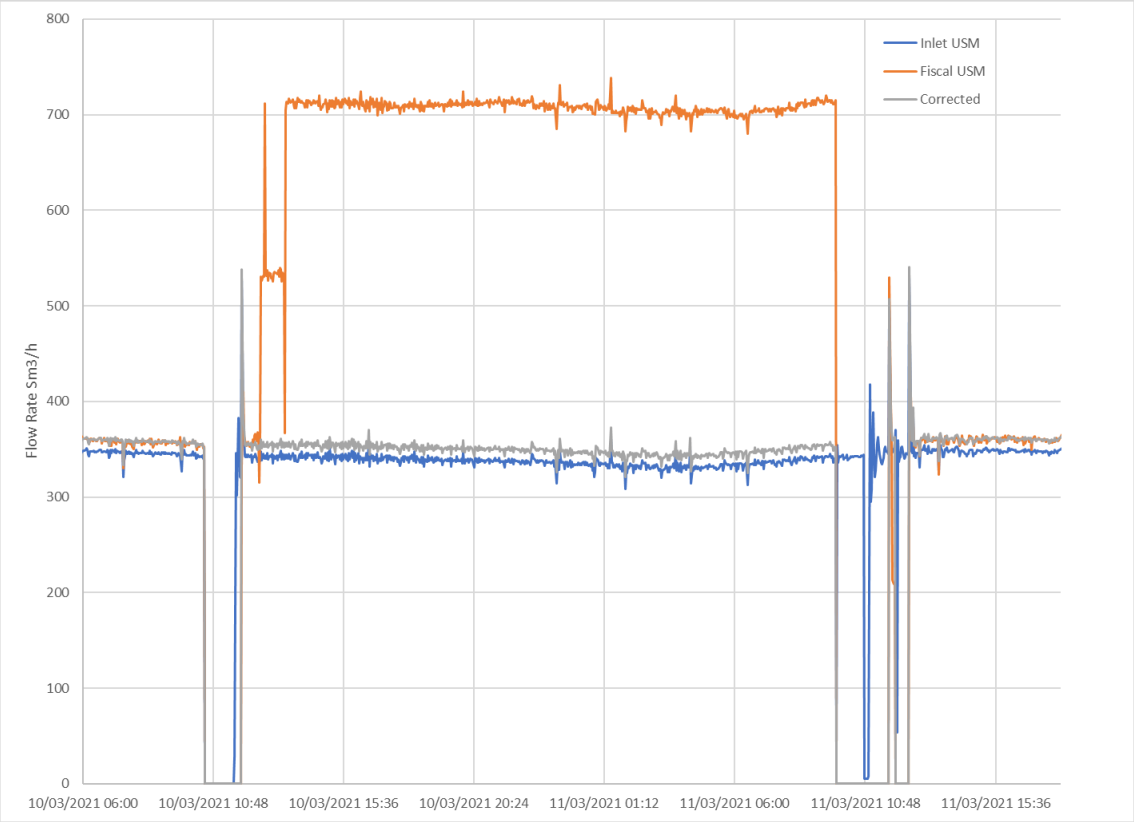

Figure 17. Error 16 Plot - March 2021

10.17 Error Period 17 – March 2021

At 04:14 on 16th March 2021, the Fiscal USM began to read ~175 Sm^3/h above the Inlet USM reading. The over registering continued until 09:54, at which point the flow was diverted to reject. When the flow returned to the grid through the Fiscal USM, the Fiscal USM read an offset within the normal operating range (~12.6 Sm^3/h).

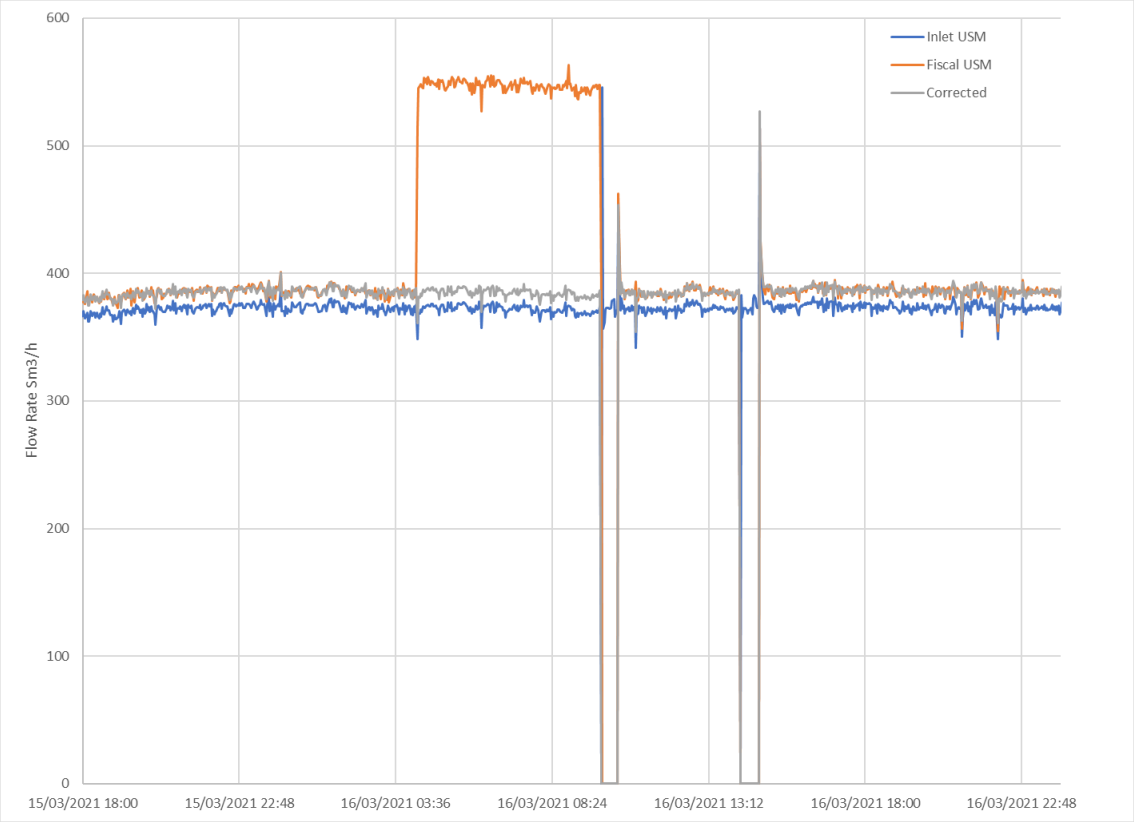

Figure 18. Error 17 Plot - March 2021

10.18 Error Period 18 – March 2021

At 03:50 on 26th March 2021, the Fiscal USM began to read ~138 Sm^3/h below the Inlet USM reading. The under registering continued until 19:09 at which point the Fiscal USM returned to an offset within the normal operating range (~14 Sm^3/h).

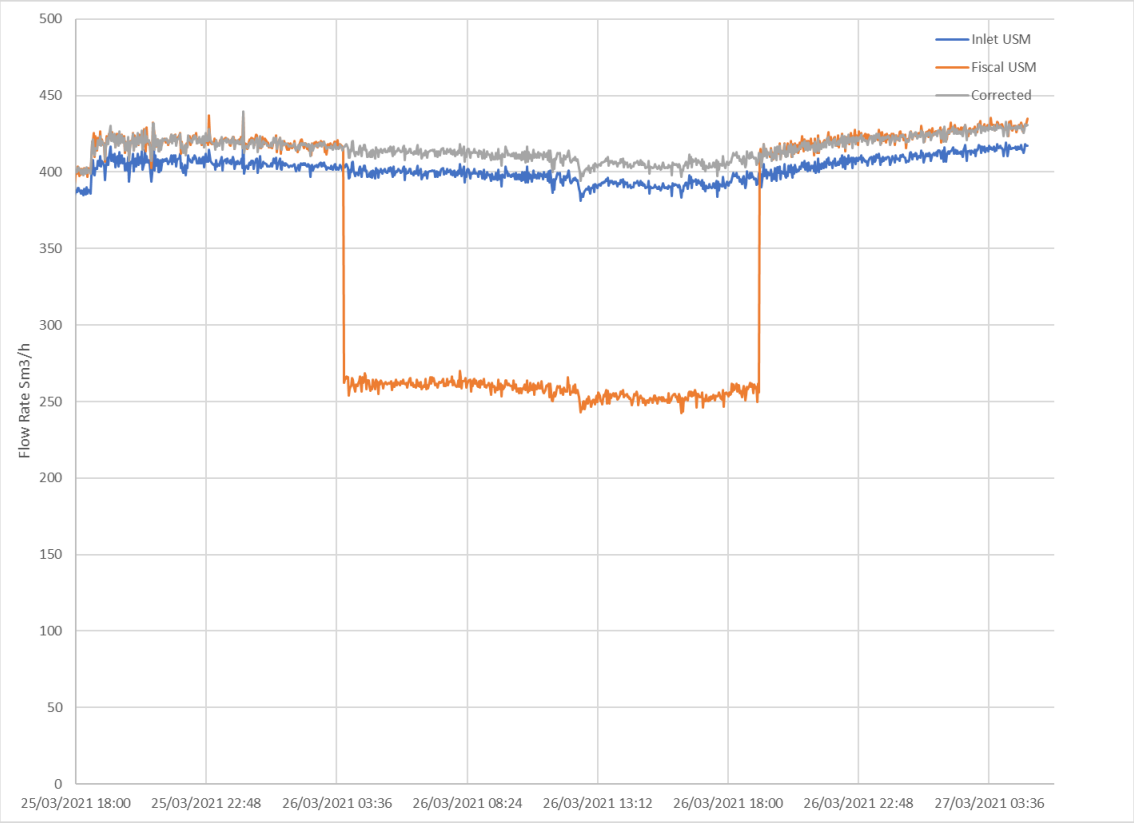

Figure 19. Error 18 Plot - March 2021

10.19 Error Period 19 – March 2021

At 10:41 on 27th March 2021, the Fiscal USM began to read ~140 Sm^3/h below the Inlet USM reading. The under registering continued until 02:48 on 28th March 2021 at which point the Fiscal USM returned to an offset within the normal operating range (~14.8 Sm^3/h).

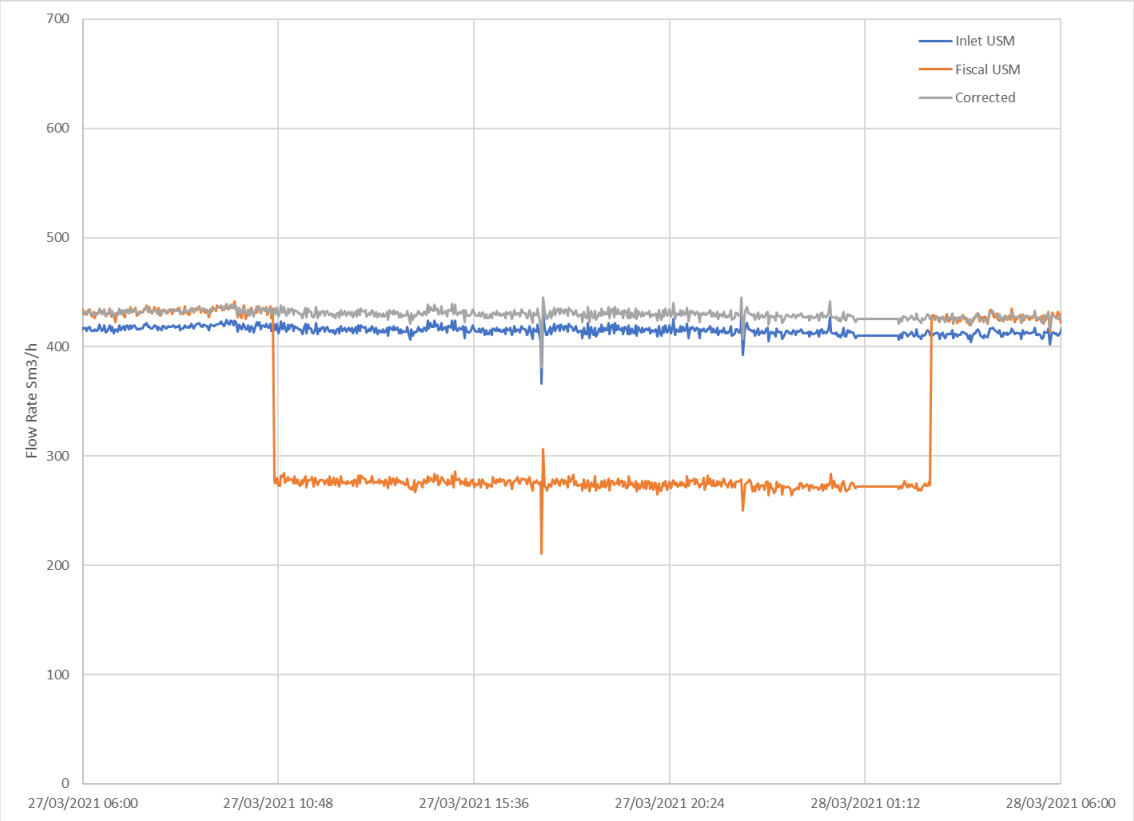

Figure 20. Error 19 Plot - March 2021

10.20 Error Period 20 – March 2021

At 02:11 on 29th March 2021 the Fiscal USM began reading ~179 Sm^3/h above the Inlet USM for ~2 hours. At 04:22 the Fiscal USM started reading the correct offset of ~15.6 Sm^3/h again.

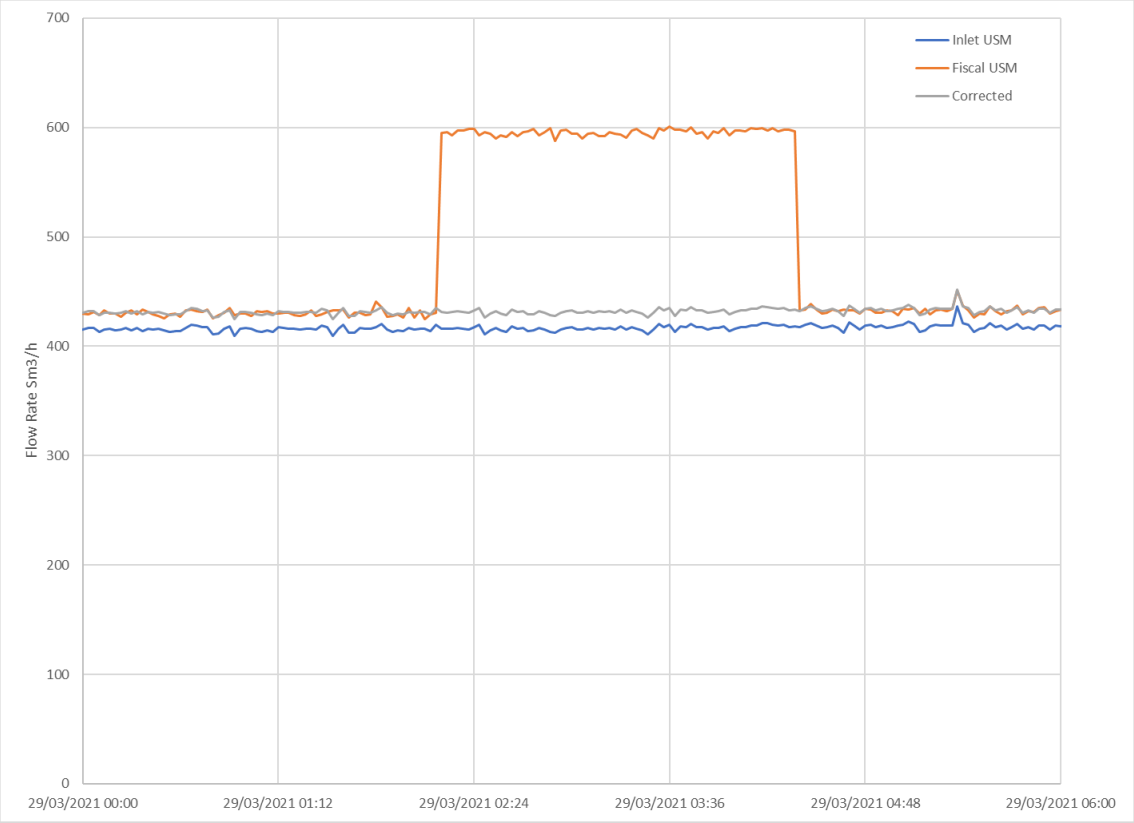

Figure 21. Error 20 Plot - March 2021

10.21 Error Period 21 – March 2021

At 22:06 on 30th March 2021, the Fiscal USM began to read ~140 Sm^3/h above the Inlet USM reading. The process flow rate began to fluctuate soon after and is shown in both the Fiscal and Inlet USM's readings. The over registering continued until 00:14 on 31st March 2021 at which point the Fiscal USM returned to an offset within the normal operating range, however the process flow rate continued to vary considerably until 00:50 on 31st March 2021.

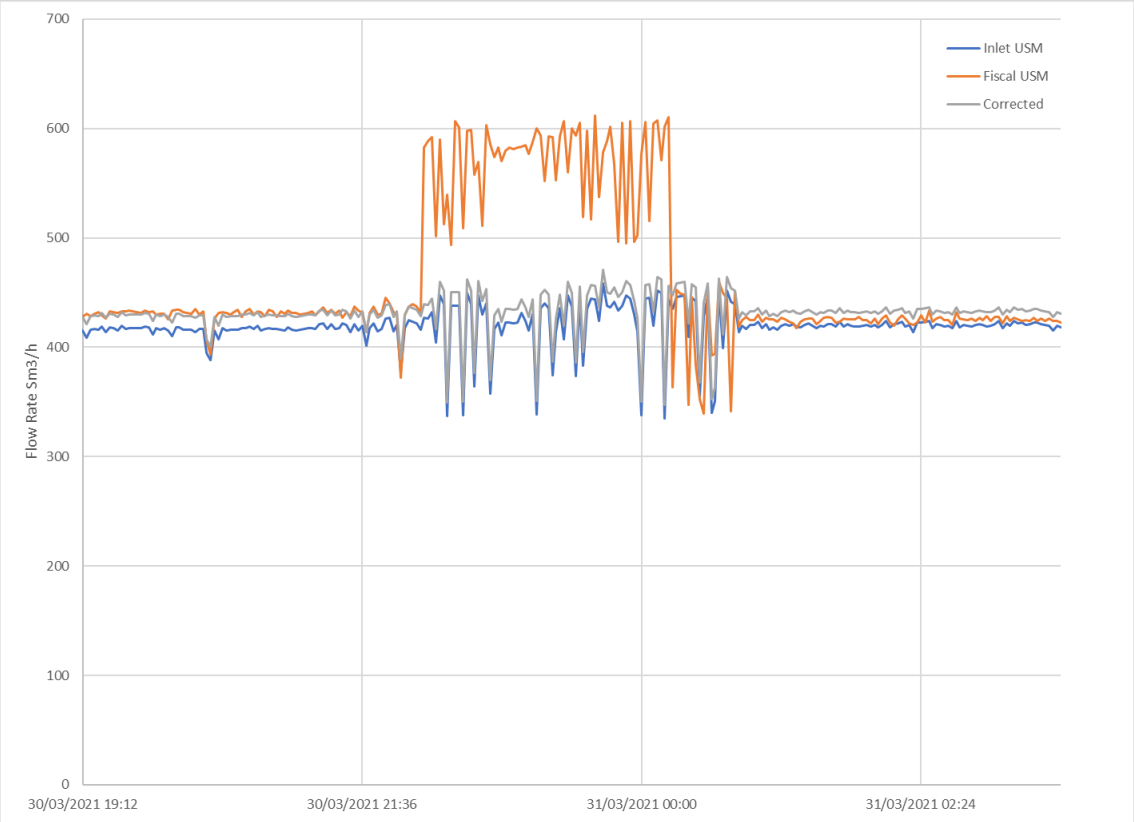

Figure 22. Error 21 Plot - March 2021

10.22 Error Period 22 – March 2021

At 12:05 on 31st March 2021, the Fiscal USM began to read ~159 Sm^3/h above the Inlet USM reading. The over registering continued until 14:02, when the process flow rate began fluctuating and the Fiscal USM misreading the flow until 17:13 on 31st March 2021.

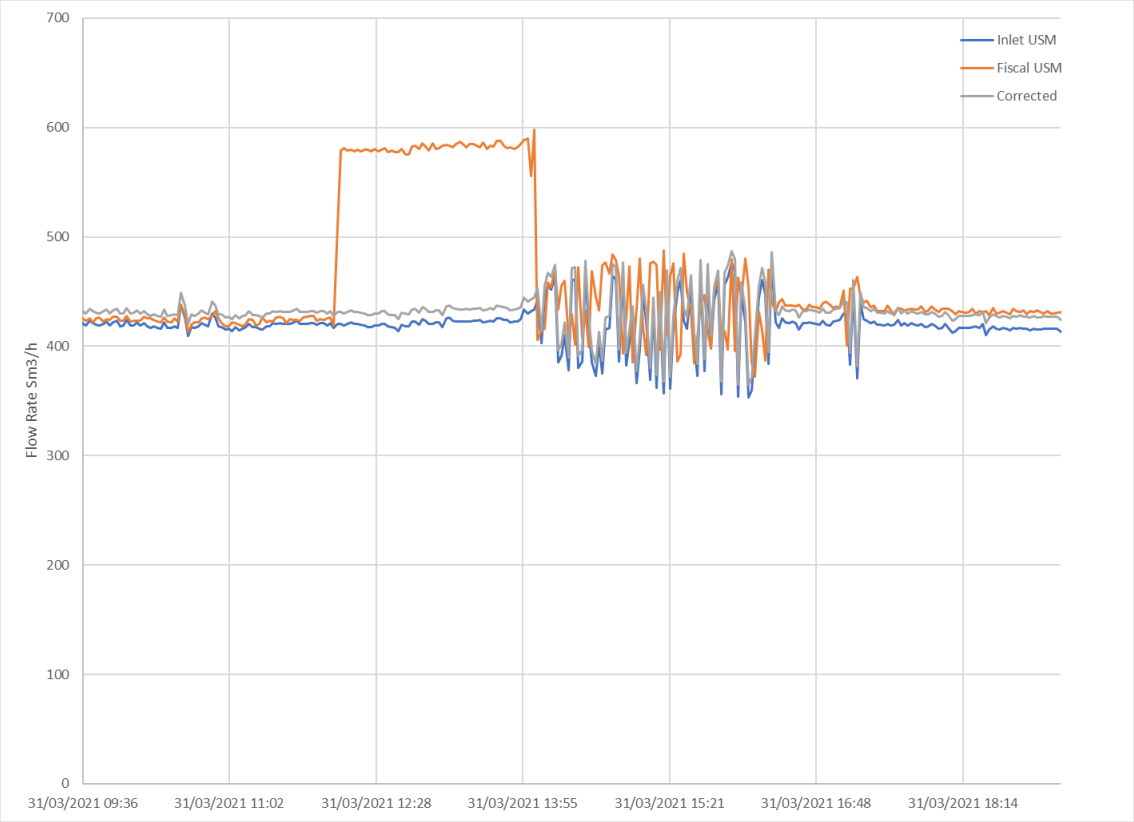

Figure 23. Error 22 Plot - March 2021

10.23 Error Period 23 – April 2021

At 16:51 on 1st April 2021, the Fiscal USM began to read ~176 Sm^3/h above the Inlet USM reading. The over reading continued until 16:17 on 4th April 2021, at which point the Fiscal USM read an offset within the normal operating range.

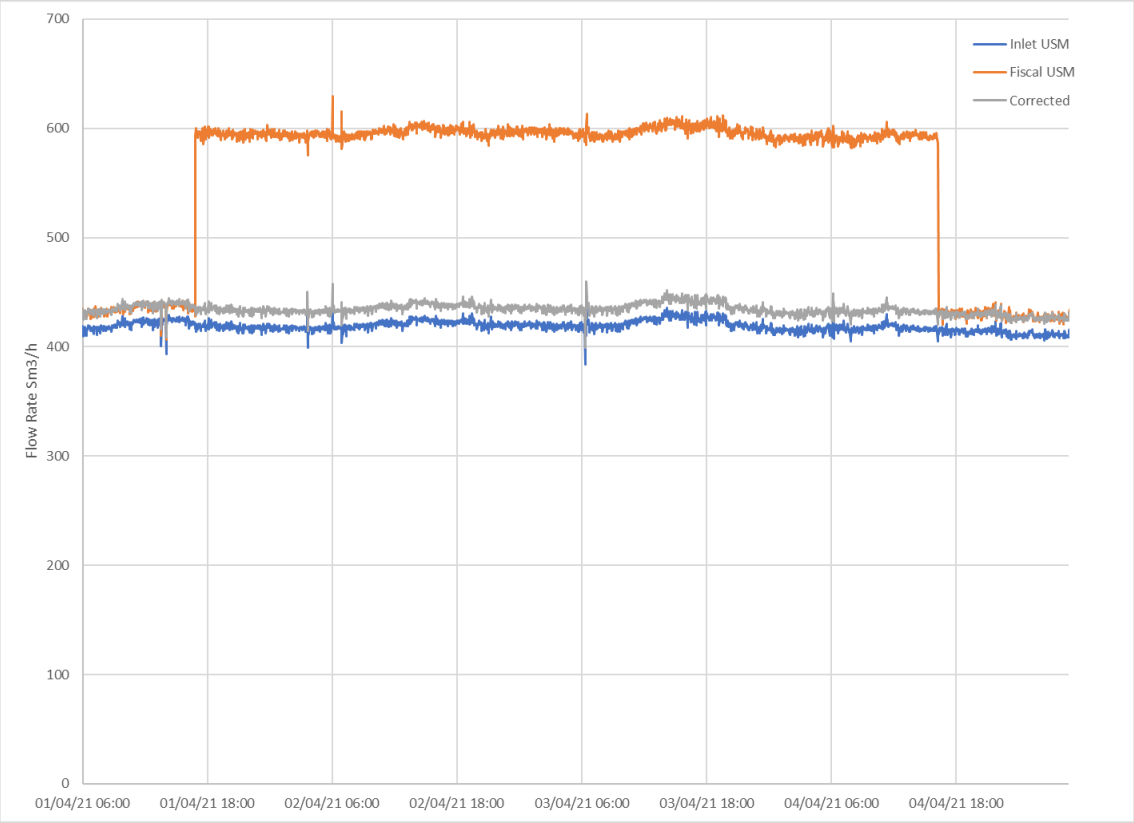

Figure 24. Error 23 Plot - April 2021

10.24 Error Period 24 – April 2021

The Fiscal USM was reading correctly on 12th April 2021 until the process was halted at 01:40. At 03:48, when the gas to grid valve was opened, the Fiscal USM started registering a flow ~145 Sm^3/h below the Inlet USM. The under registering of the Fiscal USM continued until the flow was diverted away from the grid at 12:28. Once the flow was rediverted to the grid at 15:44 the Fiscal USM began reading a normal offset.

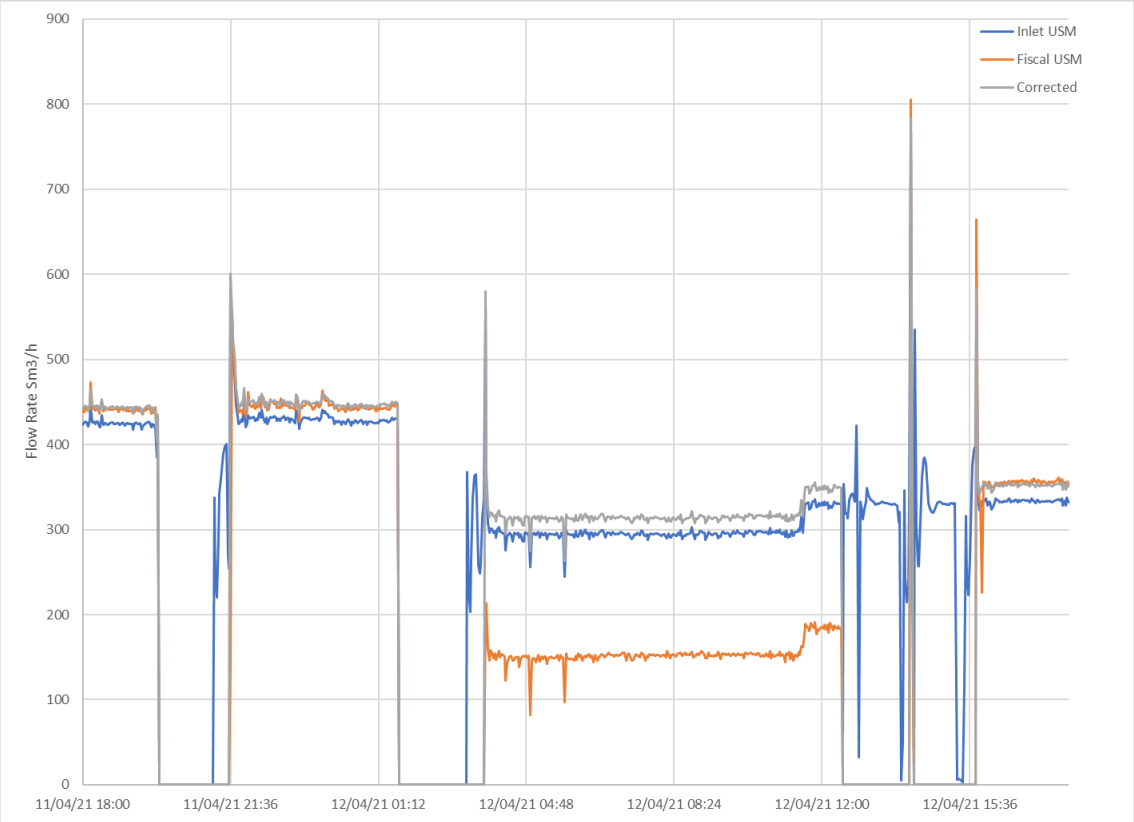

Figure 25. Error 24 Plot - April 2021

10.25 Error Period 25 – April 2021

At 11:47 on 14th April 2021 the process became unsteady with the Inlet USM reading a varying flow rate. Over which time the Fiscal USM began several short periods of under registering the flow. The process flowrate became steadier until the flow stopped at 12:53 on 15th April 2021. Once the flow was restarted and the Fiscal USM began reading a flow, it began under registering the flow with an offset of ~132 Sm^3/h below the Inlet USM, at 20:15 until 20:23. The Fiscal USM then returned to normal operation with an offset of ~21.6 Sm^3/h.

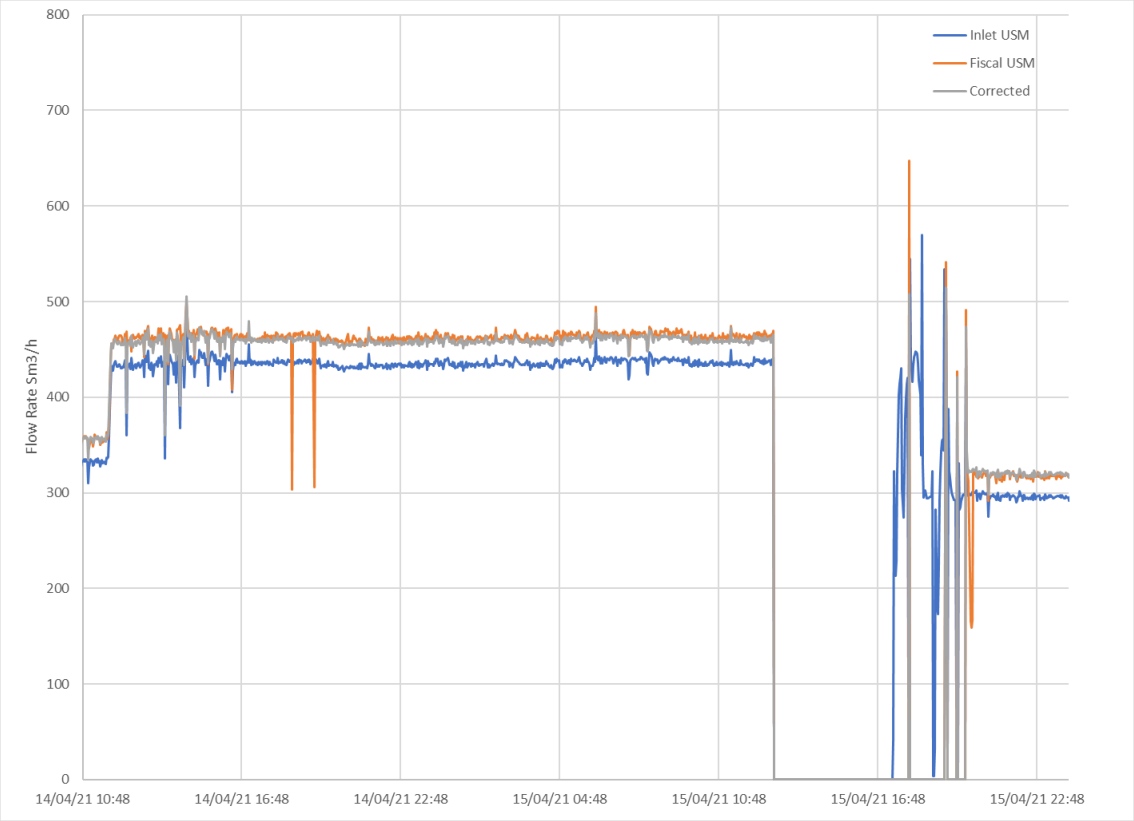

Figure 26. Error 25 Plot - April 2021

10.26 Error Period 26 – April 2021

The process was stopped at 02:27 on 19th April 2021. Once the process restarted at 04:15 the flow was diverted away from the grid and Fiscal USM. At 04:35 the flow was sent to grid and the Fiscal USM began under registering the flow with varying offsets (~65-240 Sm^3/h) below the Inlet USM. The under registering continued until 05:03, when the Fiscal USM began reading similar readings to the Inlet USM until 08:11. At which point the flow was diverted away from the grid and Fiscal USM once more and until 17:15, when it returned to grid and both meters began reading correctly.

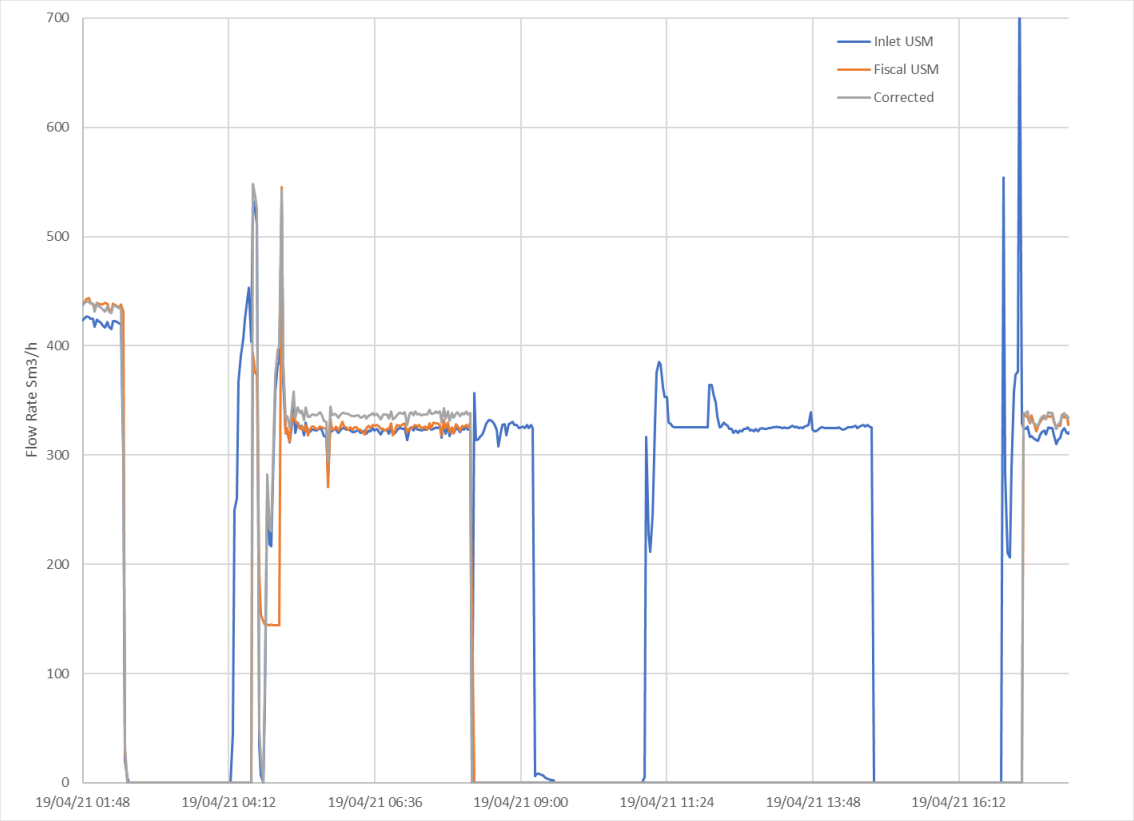

Figure 27. Error 26 Plot – 2021

10.27 Error Period 27 – May 2021

At 09:28 on 12th May 2021, the flow was diverted away from grid entry. At which point the Fiscal USM began to read a fixed flow rate of ~151 Sm^3/h. The Fiscal USM fixed reading continued until 10:49, when the gas was directed to grid entry. The Fiscal USM then began registering a large increase in flow (~144 Sm3/h for 1 minute) before operating as expected by reading an offset within the normal operating range (~25.3 Sm3/h).

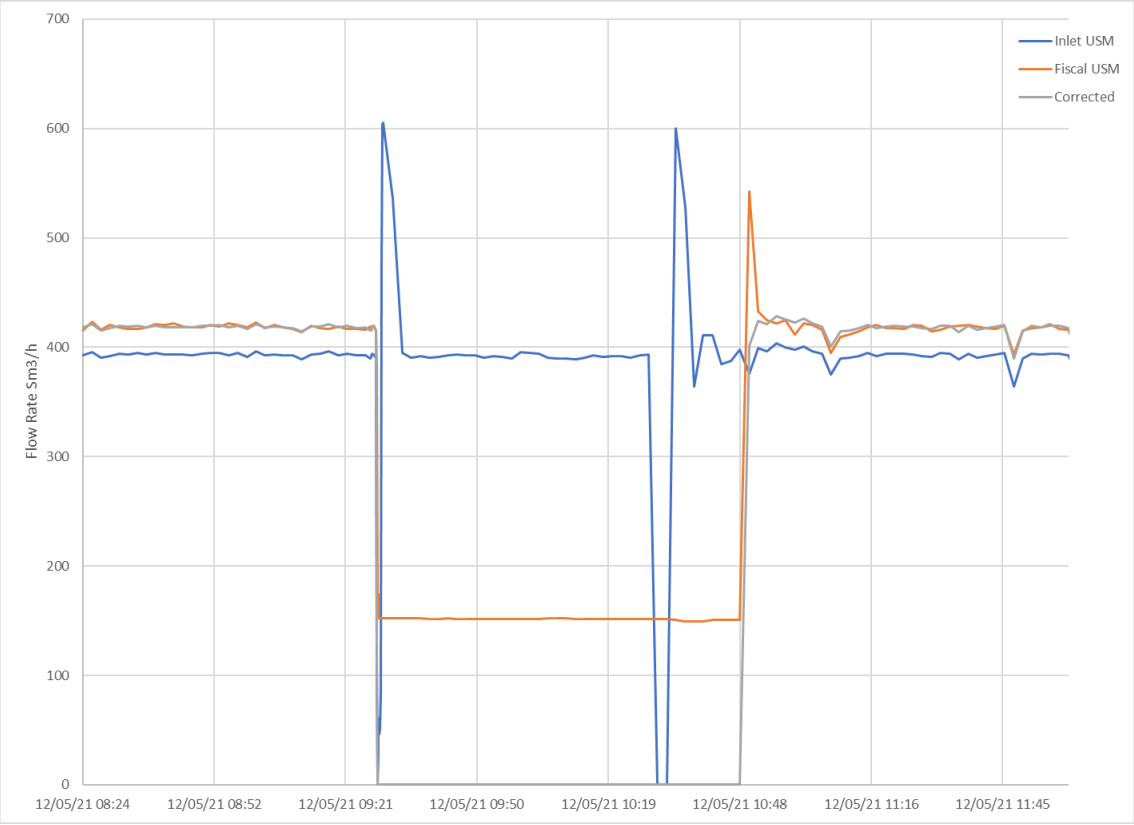

Figure 28. Error 27 Plot - May 2021

10.28 Error Period 28 – June 2021

At 06:42 on 7th June 2021 the process shut down and restarted at 10:01 with the flow being diverted away from the grid and Fiscal USM. When the gas was directed back to grid at 10:58 the reading on both the Fiscal and Inlet USM's fluctuated until the flow was diverted away from the Fiscal USM at 11:05. The flow was rediverted back to grid at 12:02 and the Fiscal USM began reading a flow within the normal operating range until 12:07 when it began under registering the flow (~136 Sm^3/h under the Inlet USM reading). The process was the shutdown at 12:19 with the Fiscal USM returning to normal operation when the flow was restarted.

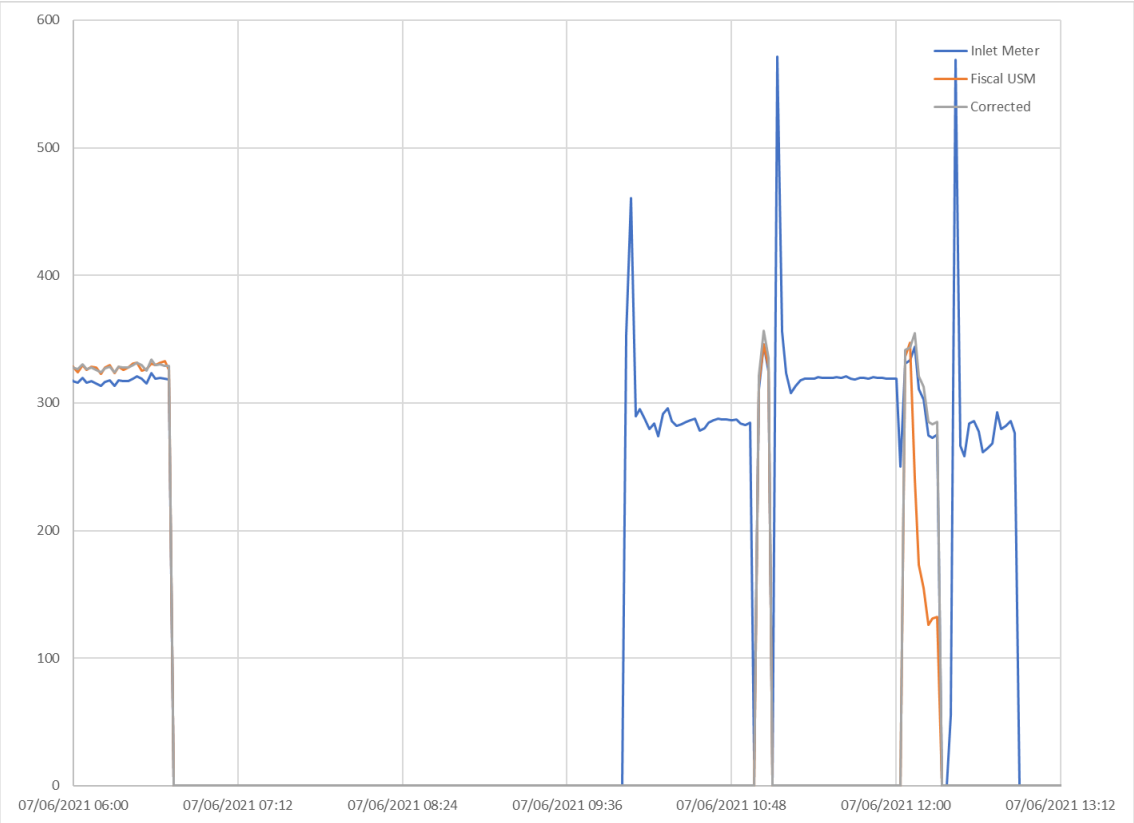

Figure 29. Error 28 Plot - June 2021

10.29 Error Period 29 – June 2021

At 17:39 on 13th June 2021 the process flow stopped with no flow being registered on the Inlet USM. However, the Fiscal USM read a fixed volumetric flow rate reading of ~153 Sm^3/h, causing an over registration. The process began flowing again at 20:20 with the Fiscal USM still reading the same fixed value. At 20:43 the Fiscal USM began reading between ~200 Sm^3/h above the Inlet USM. The process was the stopped at 20:53, with no flow being registered on the Inlet USM but a fixed value of ~140 Sm^3/h registered on the Fiscal USM. A flow was the registered on the Inlet USM at 21:34, with the Fiscal USM still reading the fixed value. At 22:05 the Fiscal USM began reading correctly until 01:30 on 14th June 2021 when the Inlet USM did not register a flow, but the Fiscal USM registered a fixed flow rate of ~150 Sm^3/h. The process started again at 09:04 with the gas being diverted and the Fiscal USM still registering the same fixed value until 12:54 when both USMs registered no flow. The process then fluctuated considerably from 16:13 with the Fiscal USM operating correctly until 23:11 when the process is stopped.

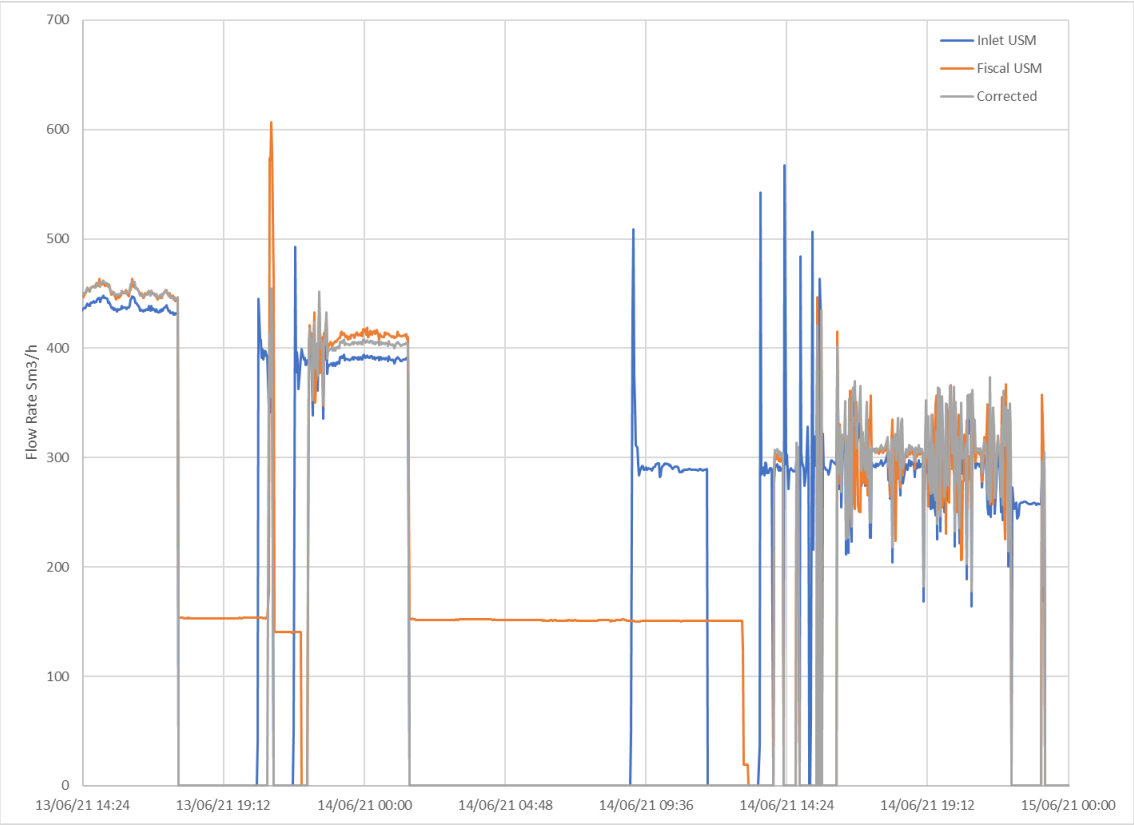

Figure 30. Error 29 Plot - June 2021

10.30 Error Period 30 – June 2021

At 12:27 on 16th June 2021 the Fiscal USM recorded a sudden increase in offset to the Inlet USM from ~11.2 Sm^3/h to ~26 Sm^3/h above the Inlet USM until 12:38 when it began under registering by reading an offset ~123.4 Sm^3/h below the Inlet USM until 12:41. The Fiscal USM then returned to over registering the flow with an offset to the Inlet USM of ~29.3 Sm^3/h until 13:59. The Fiscal USM then underread the flow considerable for 20 seconds before returning to a normal operation of ~14 Sm3/h offset above the Inlet USM.

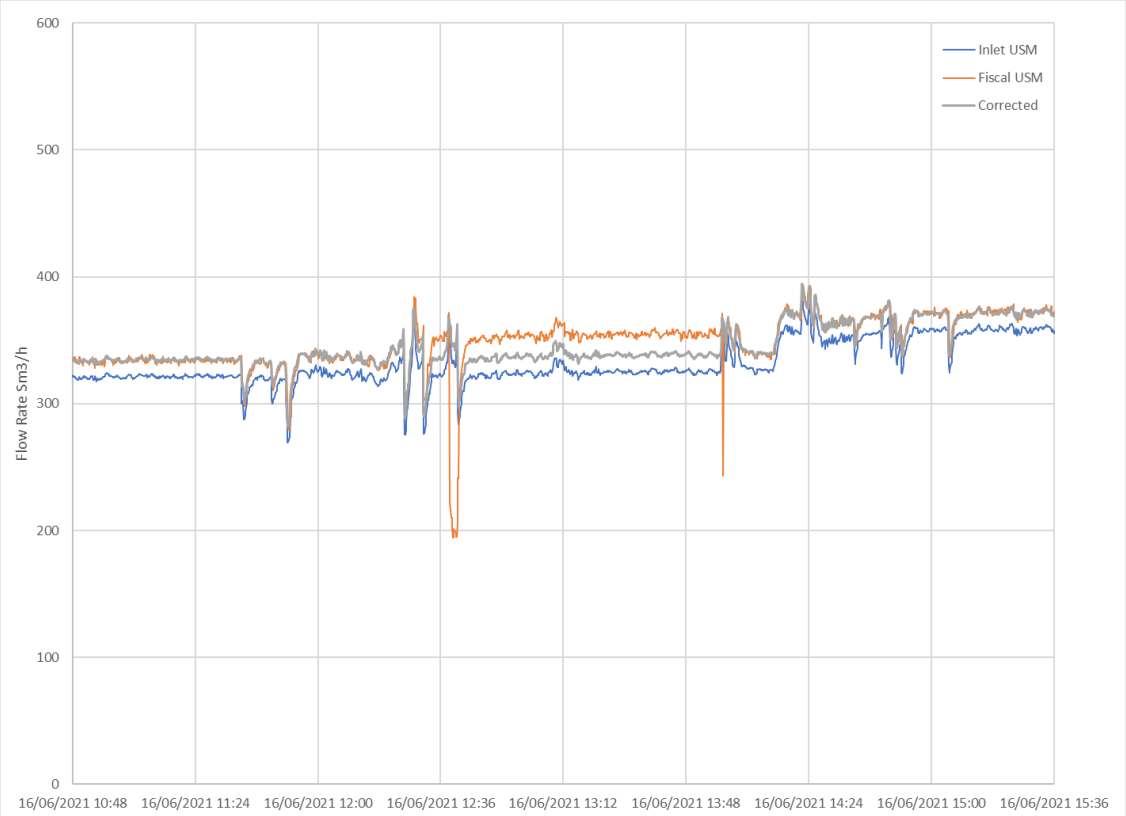

Figure 31. Error 30 Plot - June 2021

10.31 Error Period 31 – June 2021

At 20:10 on 21st June 2021 the process was stopped with no flow being registered on the Inlet USM. However, the Fiscal USM began reading a fixed flow rate of ~137 Sm^3/h. The process restarted at 21:12 with the Fiscal USM still reading a fixed flow rate until 21:28. At this point the Fiscal USM began over registering the flow with an offset of ~146 Sm3/h above the Inlet USM. The over registering continued until 21:33. At this point the Fiscal USM then began to read a very similar flow rate to the Inlet USM with an average offset of ~1.89 Sm^3/h above the Inlet USM until 22:35 at which point the Fiscal USM over read once more until the process was stopped at 22:45. However, the Fiscal USM continued to read a fixed flow rate of ~136 Sm^3/h until 22:56. The process was then restarted at 23:00 with the gas being diverted from the grid and Fiscal USM until 00:06 on 22nd June 2021 when the Fiscal USM began operating correctly.

Figure 32.Error 31 Plot - June 2021

10.32 Error Period 32 – June 2021

At 14:22 on 22nd June 2021 no flow was recorded on the Inlet USM for 10 seconds, then an increase in flow rate back to previous values over the following 80 seconds, while the diverter valve was redirecting the flow away from the grid inlet. However, the Fiscal USM began reading a fixed value of ~152 Sm3/h. The fixed reading continued until 14:40. The process was then stopped completely with no flow being registered on the Inlet USM at 15:16. At 15:23 the Fiscal USM began reading a flow rate of ~76 Sm3/h for 30 seconds while the Inlet USM still registered no flow. The process started once more at 15:33 with the flow being diverted away from the Fiscal USM and Inlet USM reading a flow rate. When the flow was redirected to grid at 15:50 the Fiscal USM under registered the flow by ~173Sm3/h for ~2.5 minutes seconds, after which the Fiscal USM began operating correctly with an offset to the Inlet USM of ~12.5 Sm3/h.

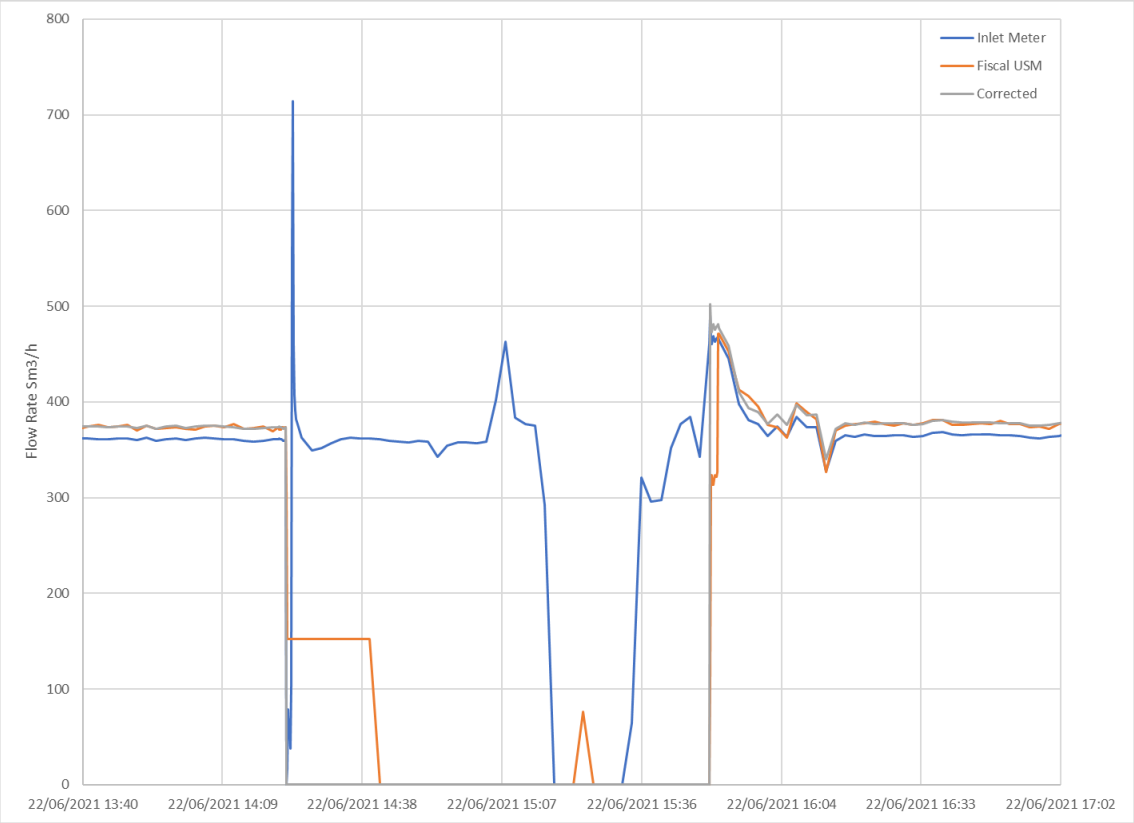

Figure 33. Error 32 Plot - June 2021

10.33 Error Period 33 – June 2021

At 15:46 on 27th June 2021 the Fiscal USM began under registering the flow until 15:56 when the process stopped. The Fiscal USM returned to normal operation once the flow was directed back to the grid at 16:34. At 20:29 the flow rate readings began to fluctuate until 20:38 when the Fiscal USM began under registering the flow until 20:49 when the process stopped (~137 Sm^3/h under the Inlet USM reading). The process restarted at 22:45 with the gas being diverted away from the grid and Fiscal USM until 00:26 on 28th June 2021 when the Fiscal USM registered the correct flow rate. Then at 00:32 the Fiscal USM under registered. The under registering continues until 00:43, when the process was stopped.

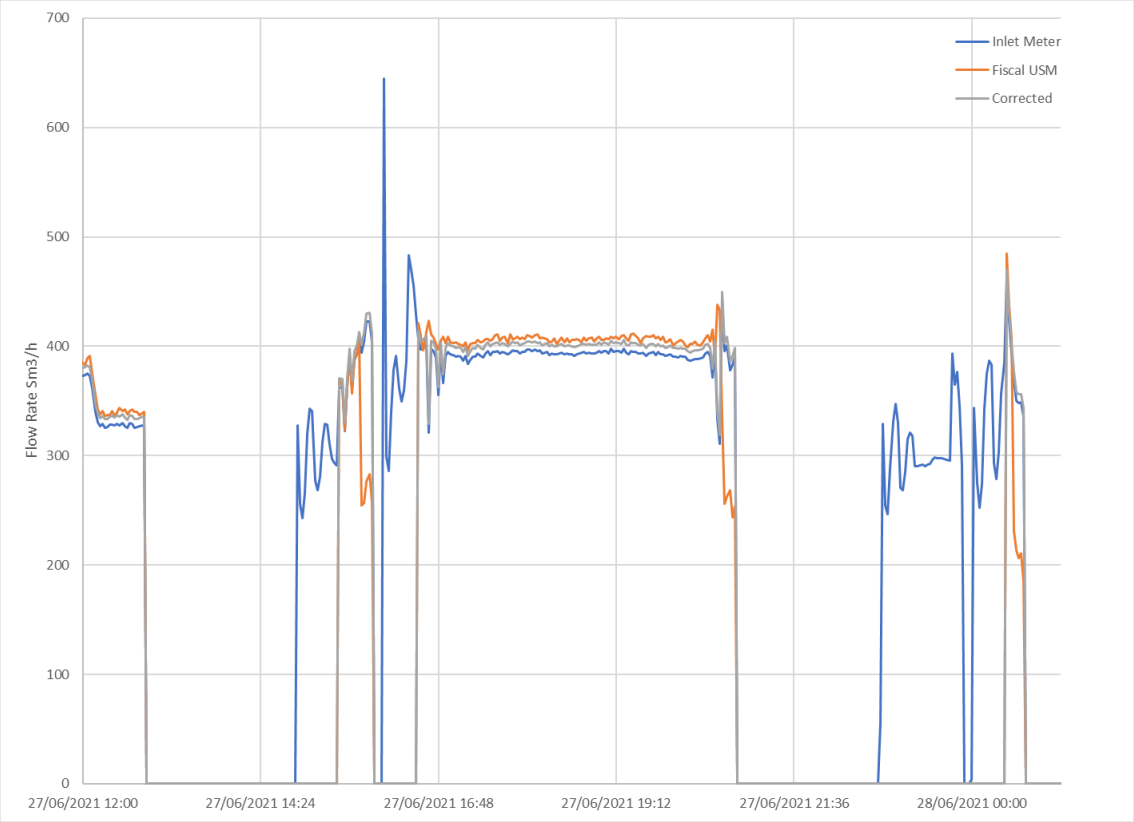

Figure 34. Error 33 Plot - June 2021

10.34 Error Period 34 – July 2021

At 11:24 on 1st July 2021 the Fiscal USM began under-reading. The process was then shut off at 11:42 and the Fiscal USM began registering a fixed flow rate of ~137 Sm^3/h until 12:50. The process then restarted at 13:05 with the flow being diverted away from the Fiscal USM until 13:37 when the flow was sent to the grid. Once the flow began flowing to grid, the Fiscal USM started over reading the flow. At 14:00 the Fiscal USM started under reading the flow. The USM continued to over and under read the flow until the process was stopped at 17:43. The Fiscal USM returned to normal operation 09:57 on 2nd July 2021.

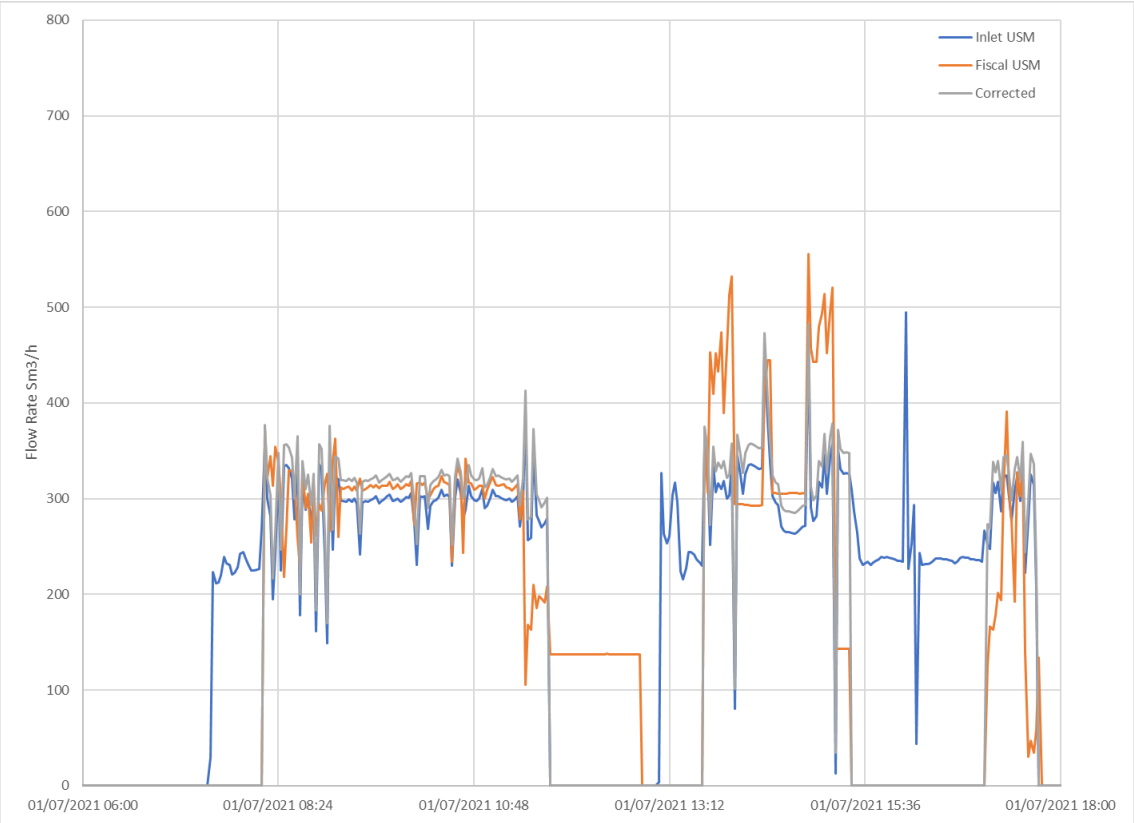

Figure 35. Error 34 Plot - July 2021

10.35 Error Period 35 – July 2021

The Fiscal USM began over reading the flow at 10:59 on 5th July 2021 for ~5 minutes and again at 11:29 for ~11 minutes. The process was then stopped, however the Fiscal USM continued to read a fixed value of ~150 Sm^3/h. The process restarted at 12:15 with the flow diverted, but the Fiscal USM continued to read the fixed value until 12:44, at which point it began over registering the flow for ~4 minutes. The Fiscal USM then under read the flow with a fixed value of ~240 Sm^3/h until 12:59 when it read no flow. When the Fiscal USM began registering a flow once more at 13:29 it started over registering. This continued until the process was halted at 13:40. The process began again at 16:18 with the Fiscal USM returning to normal operation (offset to Inlet USM of ~28.4 Sm3/h) at 16:37.

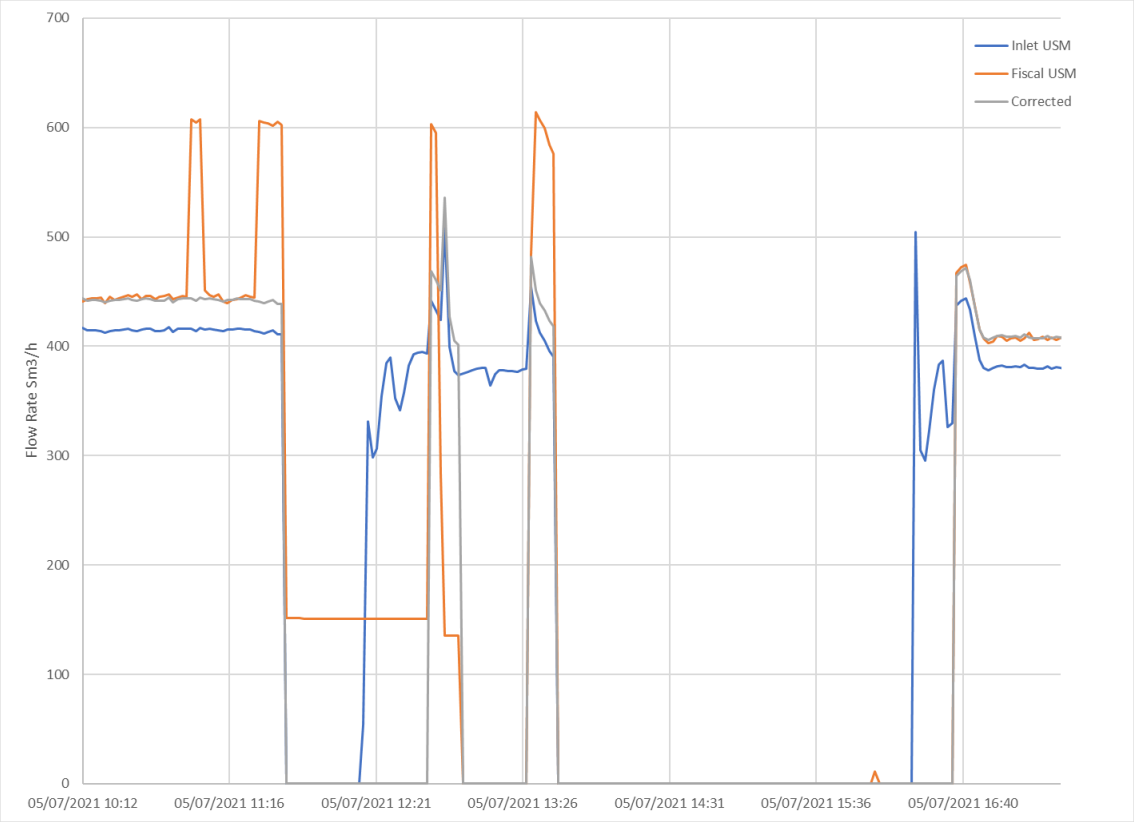

Figure 36. Error 35 Plot - July 2021

10.36 Error Period 36 – July 2021

The Fiscal USM began under reading the flow at 17:50 on 12th July 2021 for ~4 minutes and again at 18:21 for ~5 minutes before over reading at 19:48. The process was then stopped at 19:58, however the Fiscal USM continued to read a fixed value of ~150 Sm^3/h. The Fiscal USM returned to normal operation at 22:34.

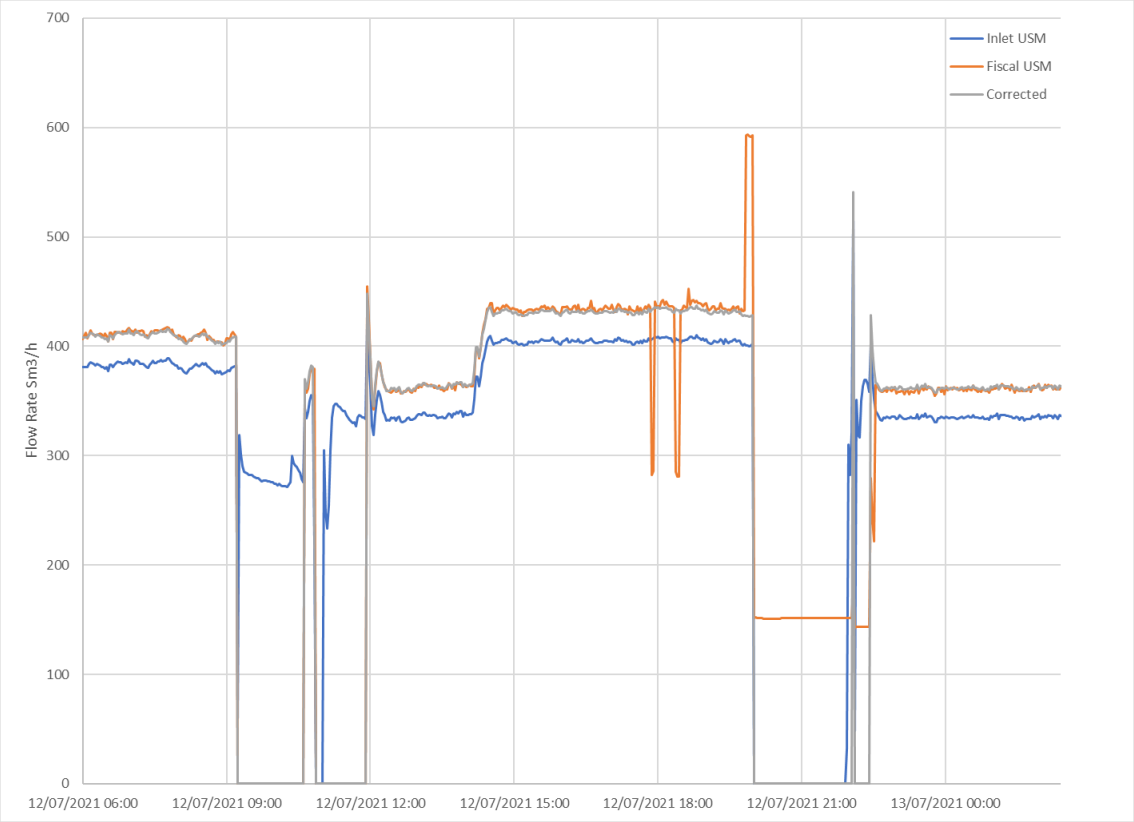

Figure 37. Error 36 Plot - July 2021

10.37 Error Period 37 – July 2021

At 11:27 on 22nd July 2021 the Fiscal USM began over registering the flow. The process was then stopped at 11:38, however the Fiscal USM continued to read a fixed value of ~276 Sm^3/h. The process restarted at 15:41, with the Fiscal USM continuing to read the fixed value until 16:09. At this point the Fiscal USM significantly over read the flow for ~9 minutes with and offset of ~337 Sm^3/h before returning a fixed value of ~273 Sm^3/h. The Fiscal USM returned to normal operation at 17:10.

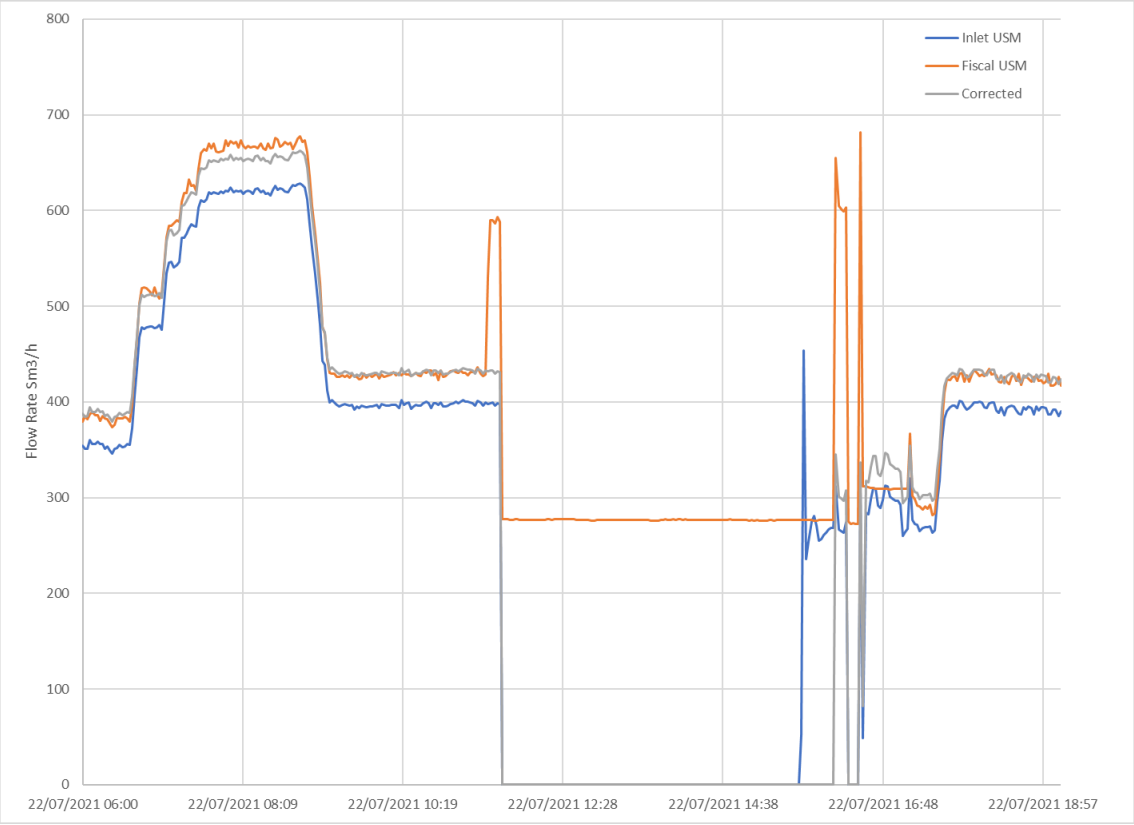

Figure 38. Error 37 Plot - July 2021

10.38 Error Period 38 – July 2021

At 12:28 on 23rd July 2021 the Fiscal USM began several short periods of under registering the flow. This continued until the process was stopped at 15:30, however the Fiscal USM began reading a fixed value of ~130 Sm3/h until 17:38. The flow restarted at 18:23 being diverted away from the Fiscal USM. The Fiscal USM returned to normal operation once the flow was directed back to the grid at 19:06.

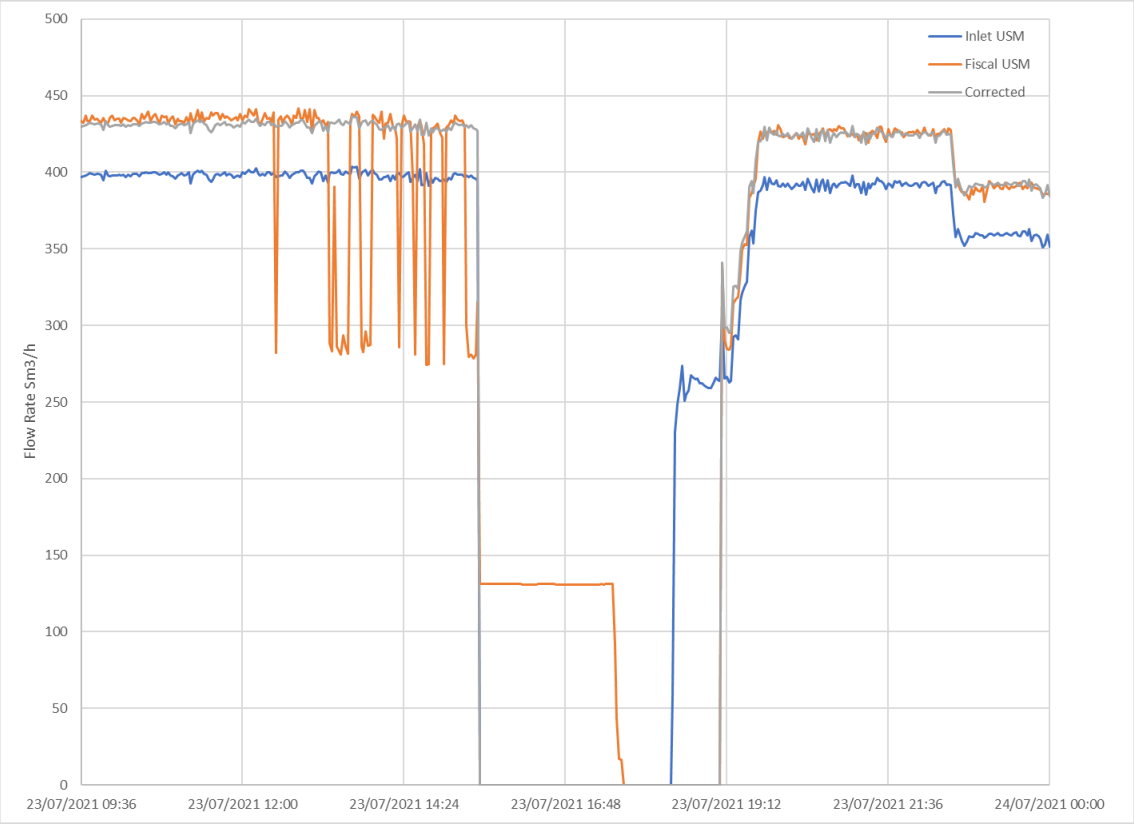

Figure 39. Error 38 Plot - July 2021

10.39 Error Period 39 – August 2021

At 19:36 on 19th August 2021 the Fiscal USM began several short periods of under registering the flow. At 21:23 the Fiscal USM began over registering until the flow was stopped at 21:33, at which point it began reading a fixed value of ~140 Sm3/h. The over reading continued until 23:15. The flow began again at 23:48 and was diverted away from the Fiscal USM until it had stabilised. The Fiscal USM returned to normal operation once the flow was directed back to the grid at 00:07 on 20th August 2021.

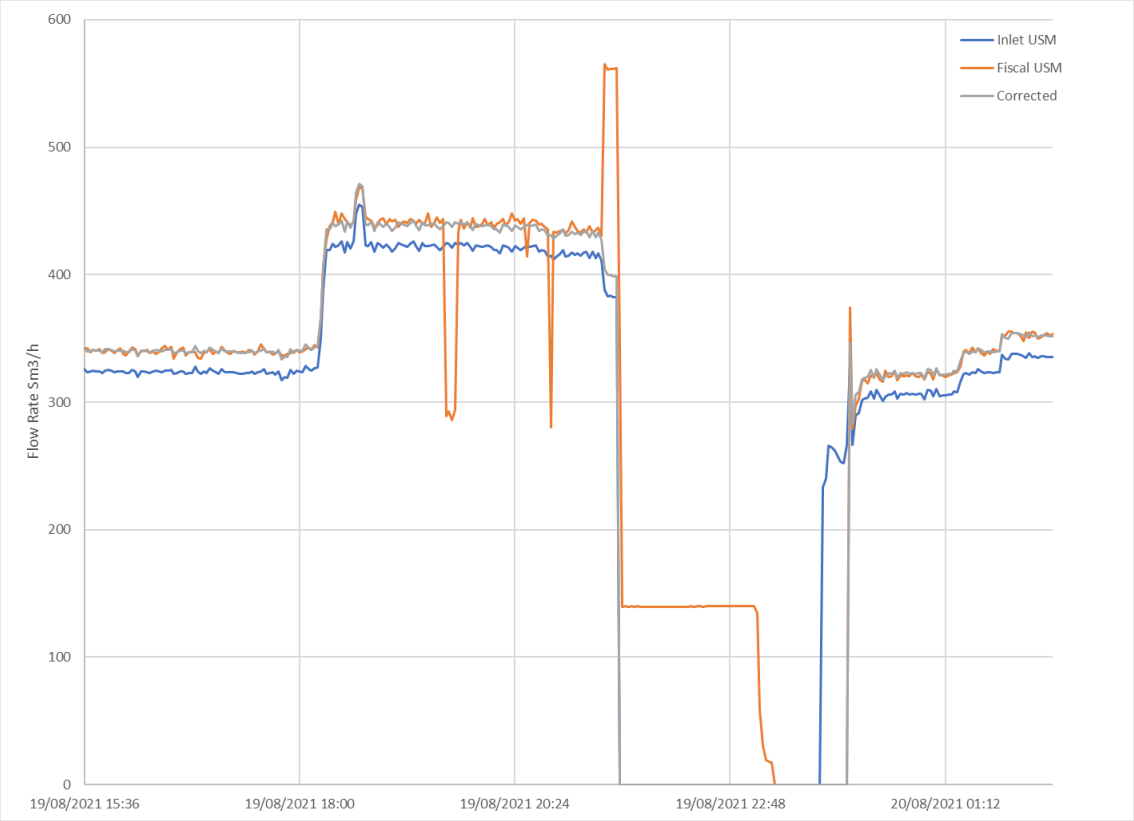

Figure 40. Error 39 Plot - August 2021

10.40 Error Period 40 – September 2021

At 16:52 on 9th September 2021 the Fiscal USM had a short period of under registering the flow. At 17:24 the Fiscal USM began over registering until the flow was stopped at 17:32, at which point it began reading a fixed value of ~135 Sm^3/h. The over reading continued until 19:28. The flow began again at 20:42 and was diverted away from the Fiscal USM until it had stabilised. The Fiscal USM returned to normal operation once the flow was directed back to the grid at 21:12.

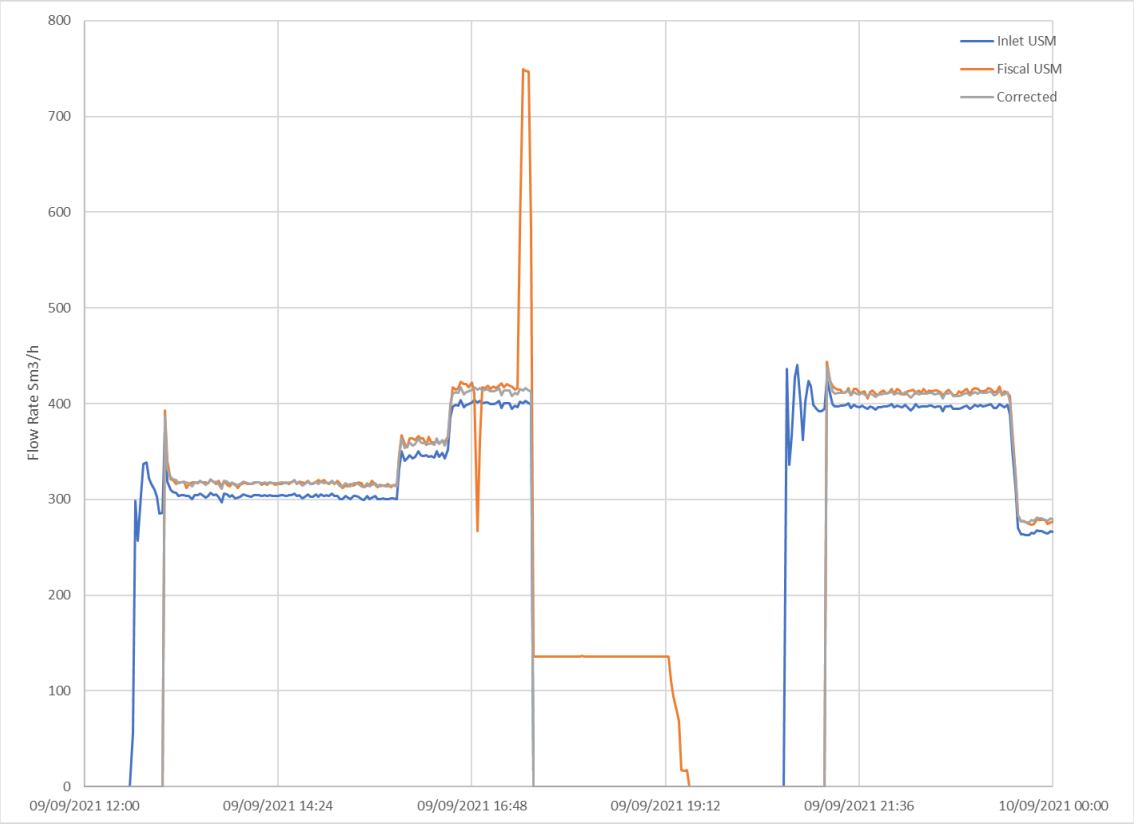

Figure 41. Error 40 Plot - September 2021

10.41 Error Period 41 – October 2021

At 10:42 on 2nd October 2021 the flow was stopped, at which point the Fiscal USM began reading a fixed value of ~140 Sm^3/h. The over reading continued until 14:28. The Fiscal USM returned to normal operation once the flow was directed back to the grid at 18:18.

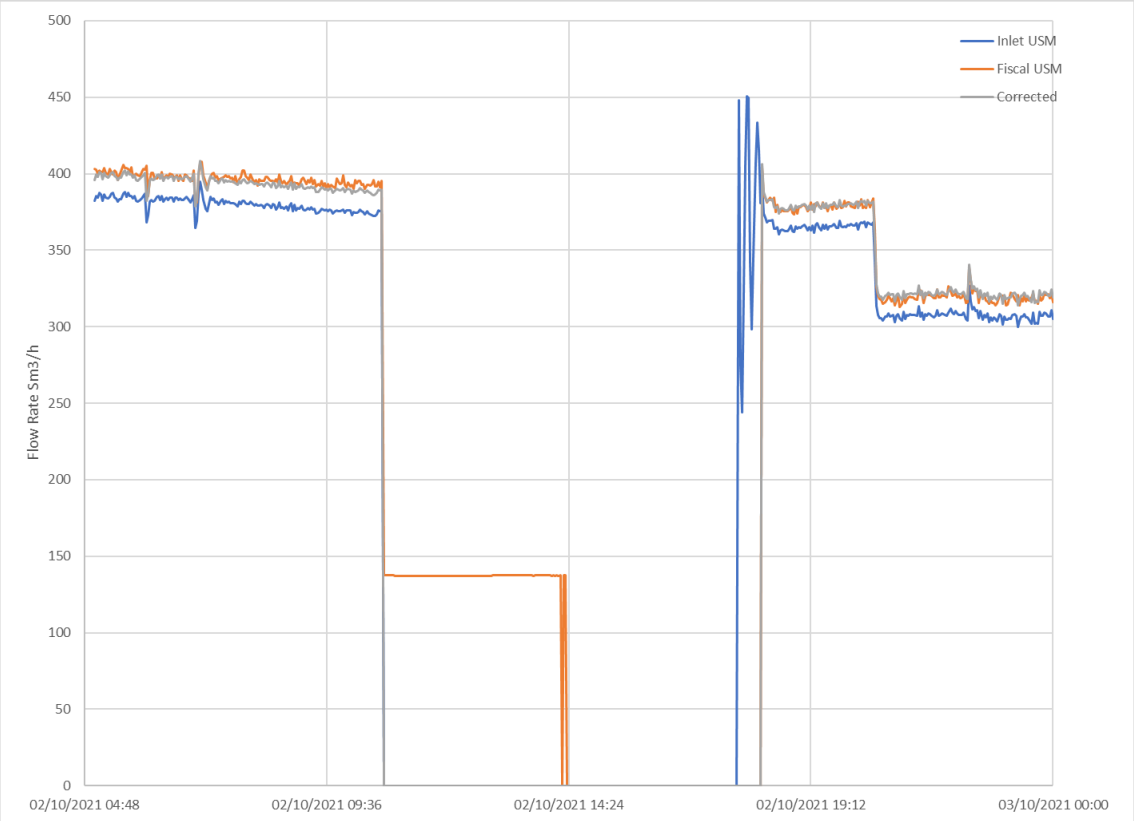

Figure 42. Error 41 Plot - October 2021

10.42 Error Period 42 – October 2021

At 01:38 on 21st October 2021 the Fiscal USM began over registering until the flow was stopped at 01:50, at which point it began reading a fixed value of ~135 Sm^3/h. The over reading continued until 03:48. The Fiscal USM returned to normal operation once the flow was directed back to the grid at 04:48.

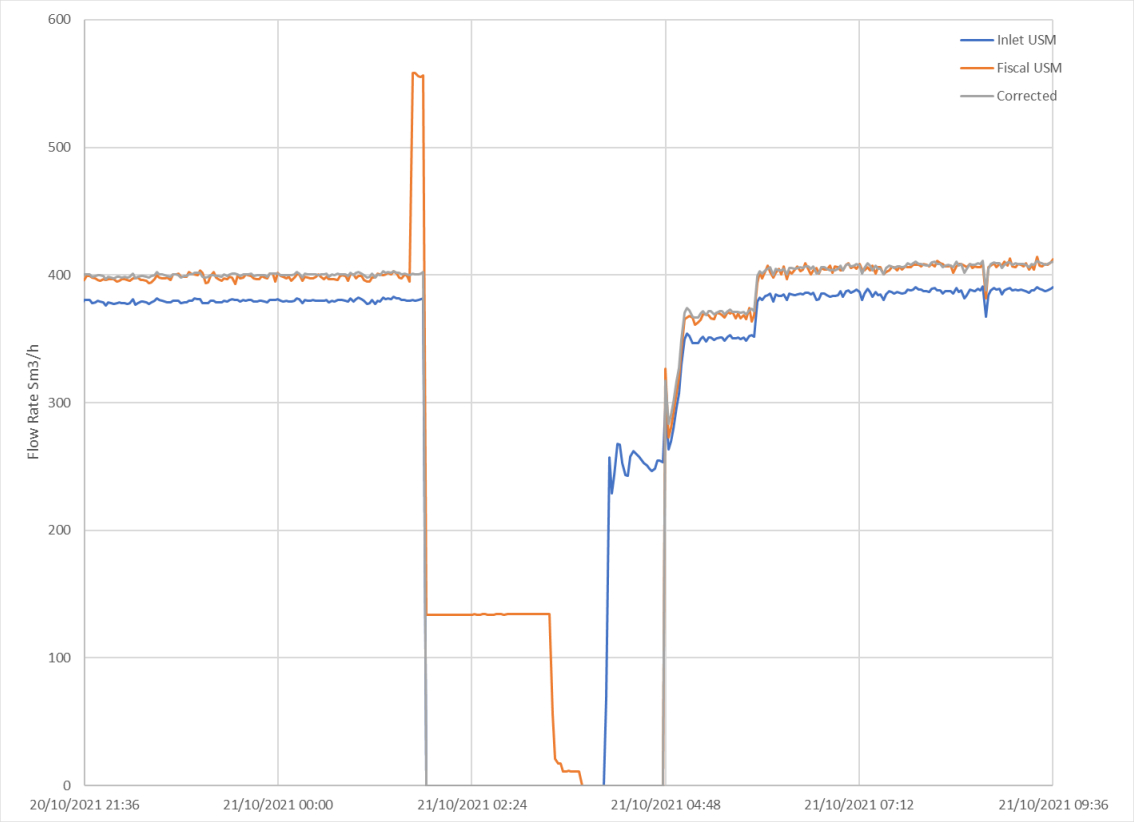

Figure 43. Error 42 Plot - October 2021

10.43 Error Period 43 – October 2021

At 18:02 on 27th October 2021 the Fiscal USM had a short period of under registering the flow. At 02:08 on 28th October 2021 the Fiscal USM began over registering until the flow was stopped at 02:38, at which point it began reading a fixed value of ~140 Sm^3/h. The over reading continued until 08:32. The Fiscal USM returned to normal operation once the flow was directed back to the grid at 09:42.

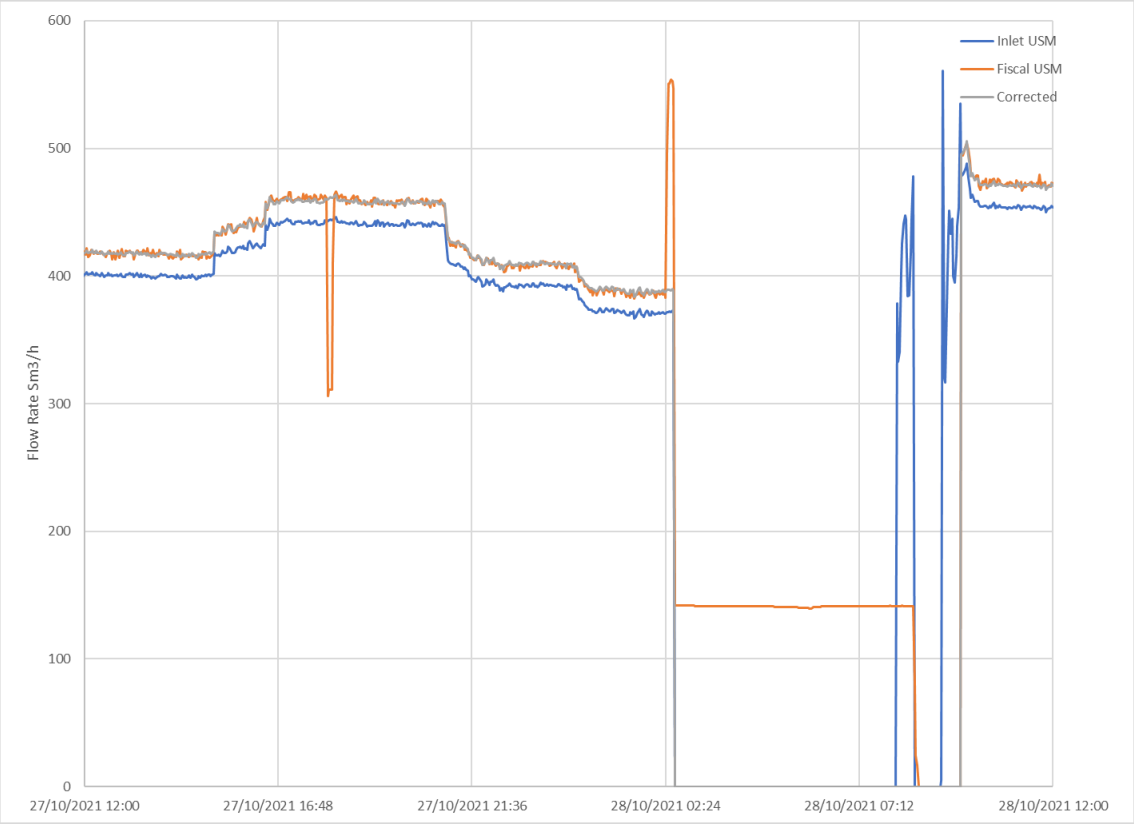

Figure 44. Error 43 Plot - October 2021