Measurement Error Report

Severn Trent PLC

MER/CAD/257/23 Derby Biogas BNEF

Document Reference: NK3225O-001

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1 Revision Control

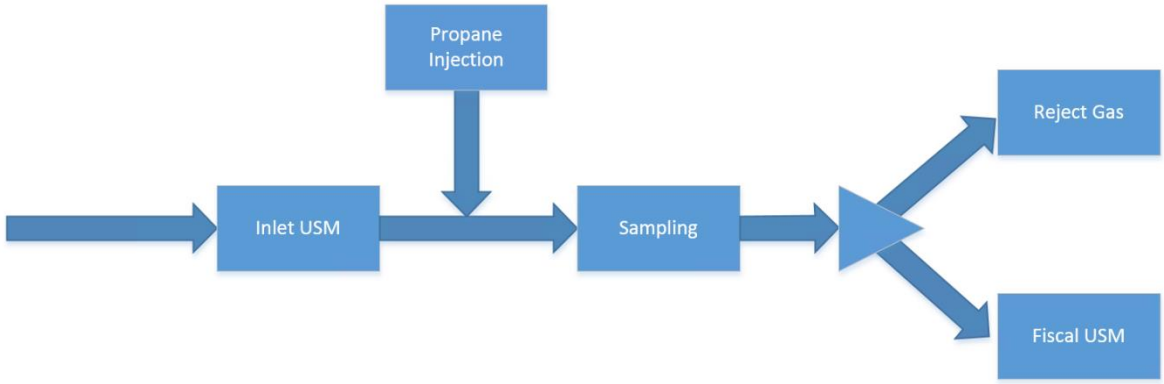
Rev	Issue date	Description	Prep.	App.
1	18/01/24	Issued for comment	TB	WD

2 Executive Summary

Site Name	Derby Biogas
DNO	Cadent Gas Limited
LDZ	East Midlands
Error Start Date	02/09/2023
(Or) Error Last Good Date	
Error Corrected Date	
Size of Error (over or under read)	455 Sm^3 over registration (0.0045 GWh)
Error Description	Erroneous readings on Fiscal meter
Methodology	Calculation of accumulated Svol totals during periods of erroneous flowrate, and subtraction of these values from the reported totals.
Meter Type	Ultrasonic
MER Unique Reference Number	
Cadent Internal Reference	MER/CAD/257/23

3 Error Description

Derby bio-methane facility has a single ultrasonic meter stream for measurement of gas exiting the grid entry unit (GEU) and entering the distribution network (referred to as Fiscal USM). A second flow meter is located on the inlet to the GEU for process control (referred to in this report as Inlet meter). 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 via a diverter valve. During normal operation the Fiscal meter will read slightly higher than the Inlet meter due to the addition of propane.



During the following dates, errors were noted:

- 02/09/23; 06:02 to 11:04
- 18/09/23; 23:42 to 19/09/23; 04:18
- 20/09/23; 17:47 to 22:31
- 26/09/23; 18:25 to 27/09/23; 06:25
- 05/12/23; 15:53 to 23:37
- 11/12/23; 04:09 to 08:11, with additional 12:07 to 12:15

4 Methodology

This report covers the month of September and found four separate measurement error events. These are described below as Error 1, Error 2, error 3 and Error 4. During data analysed it was found that although the metering supervisory uses correct gas day 05:00 to 05:00 totals for daily reporting the flow computer times are out of sync by approx. 1 and half hours. The flow computer daily totals are then out of sync by 1 and a half hours with the daily reset at approx. 06:30. This can result in significant differences between supervisory and flow computer reported daily values when the flowrate for the day is not stable.

This report also includes additional dates in December, described below as Error 5 and Error 6. It should be noted that error 6 is comprised of an initial period of 242 minutes and an additional error period of 8 minutes. For the calculation these errors periods have been combined.

4.1 Error 1 – 02/09/23

Over the period of interest, the flowrates on the fiscal meter dropped from approx. 400 Sm³ to a 'false zero' of approx. 43 Sm³; indicating the meter system had gone into reject mode but was still recording a flow. *Note: The switch to reject mode is evident from the trends in pressure and temperature.* The error consisted of the fiscal meter reading high for a total period of 302 minutes. This error affected gas days 02/09/2023 only.

The calculated error is the sum of the Fiscal Meter total standard volume flow for the affected time period. The calculated standard volume error for each gas day was then subtracted from the relevant gas day calculated daily standard volume total. The calculated energy error is then equated using the calculated standard volume error and the average CV for the error duration.

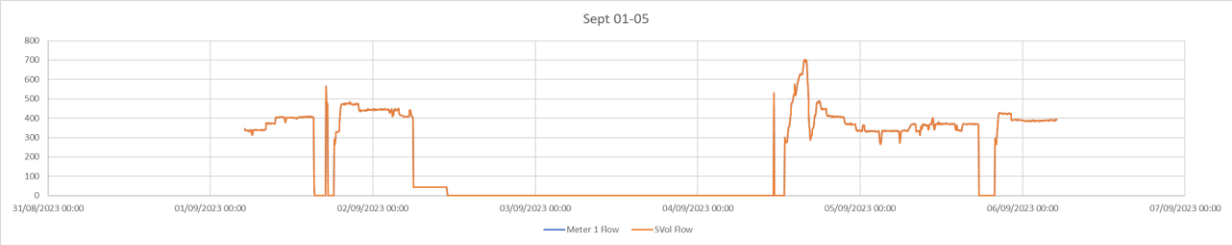


Figure 1 - Meter Volume flow rates for Fiscal Meter

4.2 Error 2 – 18/09/23

Over the period of interest, the flowrates on the fiscal meter dropped from around 600 Sm³ to a 'false zero' of approx. 97 Sm³; indicating the meter system had gone into reject mode but was still recording a flow. *Note: The switch to reject mode is evident from the trends in pressure and temperature.* The error consisted of the fiscal meter reading high for a total period of 276 minutes. This error affected gas days 18/09/2023 only.

The calculated error is the sum of the Fiscal Meter total standard volume flow for the affected time period. The calculated standard volume error for each gas day was then subtracted from the relevant gas day calculated daily standard volume total. The calculated energy error is then equated using the calculated standard volume error and the average CV for the error duration.

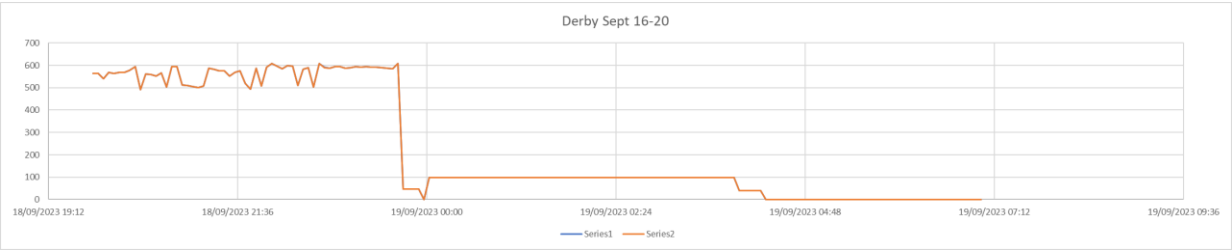


Figure 2 - Meter Volume flow rates for Fiscal Meter

4.3 Error 3 – 20/09/23

Over the period of interest, the flowrates on the fiscal meter dropped from around 300 Sm³ to a 'false zero' of approx. 57 Sm³; indicating the meter system had gone into reject mode but was still recording a flow. *Note: The switch to reject mode is evident from the trends in pressure and temperature.* The error consisted of the fiscal meter reading high for a total period of 284 minutes. This error affected gas days 20/09/27023 only.

The calculated error is the sum of the Fiscal Meter total standard volume flow for the affected time period. The calculated standard volume error for each gas day was then subtracted from the relevant gas day calculated daily standard volume total. The calculated energy error is then equated using the calculated standard volume error and the average CV for the error duration.

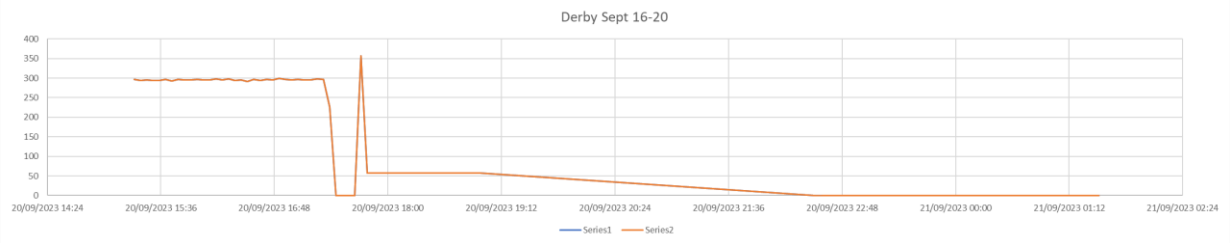


Figure 3 - Meter Volume flow rates for Fiscal Meter

4.4 Error 4 – 26/09/23

Over the period of interest, the flowrates on the fiscal meter dropped from around 640 Sm³ to a 'false zero' of approx. 56 Sm³; indicating the meter system had gone into reject mode but was still recording a flow. *Note: The switch to reject mode is evident from the trends in pressure and temperature.* The error consisted of the fiscal meter reading high for a total period of 720 minutes. This error affected gas days 26/09/2023 and 27/09/2023.

The calculated error is the sum of the Fiscal Meter total standard volume flow for the affected time period. The calculated standard volume error for each gas day was then subtracted from the relevant gas day calculated daily standard volume total. The calculated energy error is then equated using the calculated standard volume error and the average CV for the error duration.

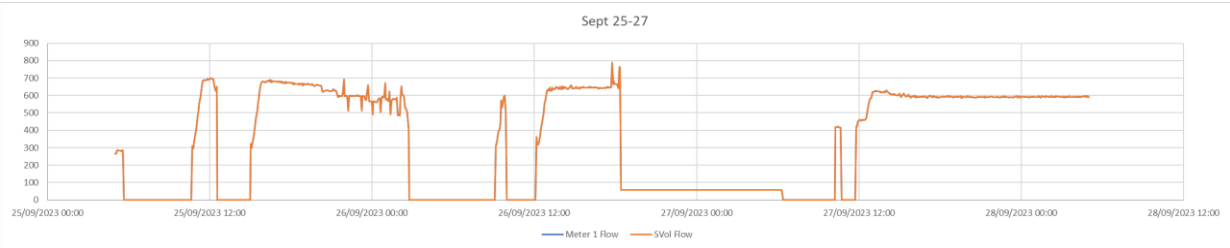


Figure 4 - Meter Volume flow rates for Fiscal Meter

4.5 Error 5 – 05/12/23

Over the period of interest, the flowrates on the fiscal meter dropped from around 730 Sm³ to a 'false zero' of approx. 80 Sm³; indicating the meter system had gone into reject mode but was still recording a flow. *Note: The switch to reject mode is evident from the trends in pressure and temperature.* The error consisted of the fiscal meter reading high for a total period of 464 minutes. This error affected gas day 05/12/2023 only.

The calculated error is the sum of the Fiscal Meter total standard volume flow for the affected time period. The calculated standard volume error for each gas day was then subtracted from the relevant gas day calculated daily standard volume total. The calculated energy error is then equated using the calculated standard volume error and the average CV for the error duration.

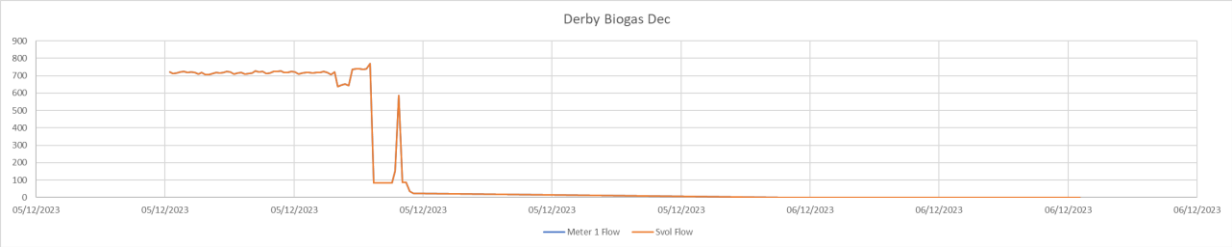


Figure 5 - Meter Volume flow rates for Fiscal Meter

4.6 Error 6 – 11/12/23

Over the period of interest, the flowrates on the fiscal meter dropped from around 750 Sm³ to a 'false zero' of approx. 35 Sm³; indicating the meter system had gone into reject mode but was still recording a flow. *Note: The switch to reject mode is evident from the trends in pressure and temperature.* The error consisted of the fiscal meter reading high for a total period of 242 minutes. This error affected gas days 10/12/2023 and 11/12/2023.

There is then an additional error period on gas day 11/12/23 evidenced by the a drop in flowrate from around 680 Sm³ to approx. 45 Sm³ resulting in an overmeasure duration of 8 minutes. This has been adding in to the proportion of the initial error that affects gas day 11/12/2023.

The calculated error is the sum of the Fiscal Meter total standard volume flow for the affected time period. The calculated standard volume error for each gas day was then subtracted from the relevant gas day calculated daily standard volume total. The calculated energy error is then equated using the calculated standard volume error and the average CV for the error duration.

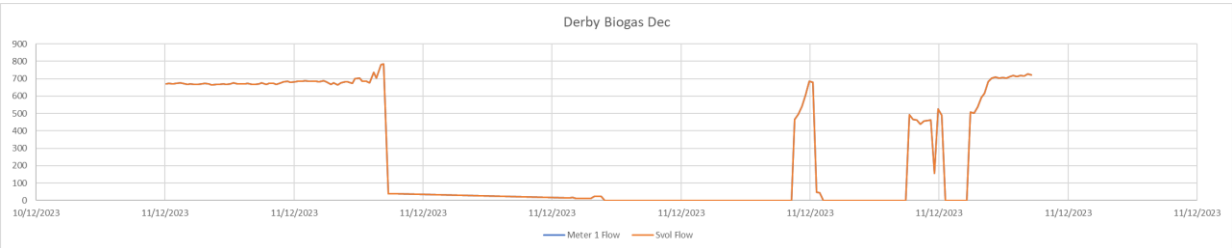


Figure 6 - Meter Volume flow rates for Fiscal Meter

5 Error Quantification

The data for each Error is detailed in the accompanying documents "MER_CAD_257_23 Derby biogas calc data Energy.xlsx"; as listed in the references as per Section 7 of this report.

The combined total error from within the Danint metering data is estimated to be an overall combined over registration of 1637 Sm^3. This equates to give an energy over measure of 62 GJ; or 0.017 GWh.

However, the Cadent Gemini data shows that corrections have been made to the reported daily totals, therefore the actual error after taking into account the Gemini corrections is an overall combined over measure of 455 Sm^3. This equates to give an energy over measure 14.15 GJ; or 0.00393 GWh.

The Gemini corrections have on some occasions led to an over-correction resulting in some affected gas days showing an error over measure and some showing an error under measure. These can be viewed in the table below.

Gas Day	Estimated Error (Sm^3) (After correction within Gemini)	Estimated Error (GJ) (After correction within Gemini)
02-Sept-2023	216 (10)	8.17 (-0.787)
18-Sept-2023	405 (423)	15.13 (16.132)
20-Sept-2023	84 (-17)	3.22 (-1.55)
26-Sept-2023	602 (35)	22.93 (0.7)
27-Sept-2023	77 (-16)	3.12 (-0.011)
05-Dec-2023	102 (26)	3.98 (1.113)
10-Dec-2023	34 (5)	1.3 (0.541)
11-Dec-2023	117 (-11)	4.28 (-1.9)

Table 1 – Daily estimated errors for the periods of mismeasurement

The daily correction factors listed in Appendix A are based on the estimated MER data against the Gemini data (bracketed values in table above) as these are the reported daily values. These correction factors should be used to correct the reported energy values for each affected gas day.
If the corrected Gemini data for these events are still outside of the 0.1% reconciliation limit as specified in the Measurement Error Notification Guidelines a further correction will have to be made.

5.1 Error 1 – 02/09/23

The error shows an overall over registration of 216 Sm³ for the duration of 302 minutes. When comparing the Gemini Initial to the Gemini Latest data it can be seen a correction has been made for the daily totals. This correction has led to an overall over registration of 10 Sm³. This value should be subtracted from the daily total.

If Energy is calculated using the average CV for the error duration rather than the average daily CV; the energy is actually an over correction. This results in an under registration in terms of Energy to 0.079 GJ or 218.5 kWh (0.0002 GWh). The MER calculation value compared to the corrected Latest Gemini data was found to vary by -4.9043%. Which is outside the 0.1% reconciliation limit as specified in the "Measurement Error Notification Guidelines from the Joint Office of Gas Transporters".

The tables below show the estimated over correction values, as seen from the Danint metering data and the obtained Latest Gemini data.

Gas Day	Daily Volume (Sm³)				
	Reported at Metering	Estimated	Est Error	Gemini Latest	Gemini Difference
02-Sept-23	626	410	216	420	10

Table 2 – Standard Volume over correction values for gas day

Gas Day	Daily Energy (GJ)				
	Reported at Metering	Estimated	Est Error	Gemini Latest	Gemini Difference
02-Sept-23	25	16.832	8.168	16.0452	-0.787

Table 3 –Energy under correction values for gas day

5.2 Error 2 – 18/09/23

The error shows an overall over registration of 405 Sm³ for the duration of 276 minutes. This value should be subtracted from the daily total. This over registration in terms of Energy equates to 15.13 GJ or 4202.4 kWh (0.0042 GWh).

The table below shows the estimated standard volume and energy for the affected gas day, as well as the reported Gemini values. The differences may be due to resolution/rounding at telemetry or an in-day correction within the Gemini data.

Gas Day	Daily Volume (Sm³)				
	Reported at Metering	Estimated	Est Error	Gemini Latest	Gemini Difference
18-Sept-23	10782	10377	405	10800	423

Table 4 – Standard Volume over correction values for gas day

Gas Day	Daily Energy (GJ)				
	Reported at Metering	Estimated	Est Error	Gemini Latest	Gemini Difference
18-Sept-23	431	415.87	15.13	432	16.132

Table 5 – Energy over correction values for gas day

5.3 Error 3 – 20/09/23

The error shows an overall over registration of 84 Sm³ for the duration of 284 minutes. When looking at the Gemini data is would seem likely an in-day correction has been made, resulting in an overall **under** registration for the gas day. The total error value in terms of energy equates to 3.2 GJ or **895.25 kWh** (0.0009 GWh).

This over correction has led to an overall **under** registration of **17 Sm³**. This value should be added onto the daily total. The MER calculation value compared to the corrected Latest Gemini data was found to vary by 0.35%. Which is outside the 0.1% reconciliation limit as specified in the "Measurement Error Notification Guidelines from the Joint Office of Gas Transporters".

This over registration in terms of Energy equates to 1.5 GJ or **431.5 kWh** (0.0004 GWh). The table below shows the estimated standard volume and energy for the affected gas day.

Gas Day	Daily Volume (Sm³)				
	Reported at Metering	Estimated	Est Error	Gemini Latest	Gemini Difference
20-Sept-23	4981	4897	84	4880	-17

Table 6 – Standard Volume under correction values for gas day

Gas Day	Daily Energy (GJ)				
	Reported at Metering	Estimated	Est Error	Gemini Latest	Gemini Difference
20-Sept-23	199	195.777	3.223	194.224	-1.554

Table 7 –Energy under correction values for gas day

5.4 Error 4 – 26/09/23 and 27/09/23

The error shows a total overall over registration of 679 Sm³ for the duration of 720 minutes. Of this error a period 635 minutes affected gas day 26/09/23 and 85 minutes affected gas day 27/09/23. This total over registration in terms of Energy equates to 26.7 GJ or 7414.4 kWh (0.0074 GWh).

When looking at the Gemini data it would appear that an in-day corrections have been made. The Gemini data shows a difference in reported energy of -0.41% for gas day 26/09/23 and 0.027% for gas day 27/09/23. As a result no reconciliation is necessary for gas day 27/09/23 as per the Measurement Error Guidelines. The error values for this day have still be included when calculating total error for the purpose of this MER report, these equate to 77 Sm³ and 3 GJ; 867 kWh.

Therefore, the actual error values for this period are the values affecting gas day 26/09/23 only. Meaning a total overall over registration of **602 Sm³** which should be deducted from the daily total. This registration in terms of Energy equates to 22.927 GJ or **6368 kWh** (0.0064 GWh). The table below shows the estimated standard volume and energy for the affected gas day.

Gas Day	Daily Volume (Sm^3)				
	Reported at Metering	Estimated	Est Error	Gemini Latest	Gemini Difference
26-Sept-23	4847	4245	602	4280	35
27-Sept-23*	10413*	10336*	77*	10320*	-16*

Table 8 – Standard Volume over correction values for gas day

Gas Day	Daily Energy (GJ)				
	Reported at Metering	Estimated	Est Error	Gemini Latest	Gemini Difference
26-Sept-23	193	170.07	22.93	170.77	0.7
27-sept-23*	415*	411.88*	3.12*	411.77*	-0.11*

Table 9 – Energy over correction values for gas day

*No reconciliation required for this gas day as reported and estimated end of day values are within the 0.1% allowed limit.

5.5 Error 5 – 05/12/23

The error shows an overall over registration of 102 Sm^3 for the duration of 464 minutes. This value should be subtracted from the daily total. This over registration in terms of Energy equates to 3.98 GJ or 1105 kWh (0.0011 GWh).

The table below shows the estimated standard volume and energy for the affected gas day, as well as the reported Gemini values. The differences may be due to resolution/rounding at telemetry or a previous in-day correction within the Gemini data.

Gas Day	Daily Volume (Sm^3)				
	Reported at Metering	Estimated	Est Error	Gemini Latest	Gemini Difference
05-Dec-23	7866	7764	102	7790	26

Table 10 – Standard Volume over correction values for gas day

Gas Day	Daily Energy (GJ)				
	Reported at Metering	Estimated	Est Error	Gemini Latest	Gemini Difference
05-Dec-23	309	305.02	3.98	306.15	1.13

Table 11 – Energy over correction values for gas day

5.6 Error 6 – 10/12/23 and 11/12/23

The error is actually a combination of two errors.
The main error shows an overall over registration of 146 Sm³ for the duration of 242 minutes. Of this error a period 51 minutes affected gas day 10/12/23 and 191 minutes affected gas day 11/12/23. This total over registration in terms of Energy equates to 5.4 GJ or 1497.5 kWh (0.0015 GWh).
There is then an additional minor mismeasurement event on gas day 11/12/23 showing an additional over registration of 5 Sm³ for a duration of 8 minutes.

When looking at the Gemini data it would appear that an in-day corrections have been made. The Gemini data shows a difference in reported energy of -0.88% for gas day 10/12/23 and 0.46% for gas day 11/12/23. As a result no reconciliation is necessary for gas day 10/12/23 as per the Measurement Error Guidelines. The error values for this day have still be included when calculating total error for the purpose of this MER report, these equate to 34 Sm³ and 31.3 GJ; 360 kWh.

Therefore, the actual error values for this period are the values affecting gas day 11/12/23 only. This includes both error events on this day.
The portion of the first error event effecting gas day 11/12/23 shows a total overall over registration of 112 Sm³ which should be deducted from the daily total. This registration in terms of Energy equates to 4.09 GJ or 1135.7 kWh (0.001136 GWh).
The second error event effecting gas day 11/12/23 shows an additional overall over registration of 5 Sm³ which should be deducted from the daily total. This registration in terms of Energy equates to 0.2 GJ or 53.2 kWh.
This gives a combined overall error for gas day 11/12/23 of 117 Sm³ and 4.28 GJ, 1188.85 kWh (0.00119 GWh).
As a result of in-day corrections within the Gemini this error is actually an under registration. The table below shows the estimated standard volume and energy for the affected gas day.

Gas Day	Daily Volume (Sm³)				
	Reported at Metering	Estimated	Est Error	Gemini Latest	Gemini Difference
10-Dec-23*	15619*	15585*	34*	15590*	5*
11-Dec-23	10608	10491	117	10480	-11

Table 12 – Standard Volume over correction values for gas day

Gas Day	Daily Energy (GJ)				
	Reported at Metering	Estimated	Est Error	Gemini Latest	Gemini Difference
10-Dec-23*	615*	613.7*	1.3*	15590*	0.54*
11-Dec-23	417	412.7	4.3	410.8	-1.9

Table 13 – Energy over correction values for gas day

*No reconciliation required for this gas day as reported and estimated end of day values are within the 0.1% allowed limit.

6 Learning

Contamination on the Fiscal ultrasonic meter transducers, likely from the propane injection system, has caused the meter to read erroneously. Ongoing testing suggests this may be the result of the transportation/bunkering methods. It is recommended considering additional liquid filtration on the propane injection line and/or additional filtration on the propane tank outlet.

Consideration should be given to implementing a live comparison between the fiscal and non-fiscal (inlet plus propane) meters to give an early warning of any measurement error. Additionally, continual monitoring, recording and time/date stamping the diverter valve position in order to ascertain if the system was recirculating or flowing to the distribution network. This would result in easier analysis if measurement errors were to occur again.

7 References

Gemini Billed Daily Volumes

MER_CAD_257_23 Deby biogas 3225O 01-05 E1	Calculation Spreadsheet
MER_CAD_257_23 Deby biogas 3225O 06-10	Calculation Spreadsheet
MER_CAD_257_23 Deby biogas 3225O 11-15	Calculation Spreadsheet
MER_CAD_257_23 Deby biogas 3225O 16-20 E2&3	Calculation Spreadsheet
MER_CAD_257_23 Deby biogas 3225O 21-25 E1	Calculation Spreadsheet
MER_CAD_257_23 Deby biogas 3225O 25-27 E5	Calculation Spreadsheet
MER_CAD_257_23 Deby biogas 3225O 28-31	Calculation Spreadsheet
MER_CAD_257_23 Derby biogas Dec E5&6	Calculation Spreadsheet
MER_CAD_257_23 Deby biogas results data	Calculation Spreadsheet

Appendix A – Daily Correction Factors

The error should be corrected using the Daily Correction Factors applied to the Gemini Daily Energy totals as detailed below. The Daily Correction Factor is the ratio of the estimated energy to the Latest Gemini energy for each respective gas day.

(Values in brackets denote correction factor as calculated but EOD values are within the Measurement Error Guidelines 0.1% reconciliation limit).

Gas Day	Latest Gemini Daily Energy (kWh)	Daily Correction Factor
02-Sept-2023	4457	1.049043
18-Sept-2023	120,001	0.962657
20-Sept-2023	53,951	1.007999
26-Sept-2023	47,437	0.991579
27-Sept-2023	114,380	1 *(1.000269)*
05-Dec-2023	85,041	0.996319
10-Dec-2023	170,624	1 *(0.999119)*
11-Dec-2023	114,116	1.004631

Table 14 – Daily correction factors for the periods of mismeasurement