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Client : SCOTIA GAS NETWORKS

Project Title : MEASUREMENT ERROR REPORT

Document Title : MER SC014 LOCKERBIE OFFTAKE

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Client Ref. : PO 1617014762

REV	ISSUE DATE	DESCRIPTION	PREP. BY	APP. BY
1	28/06/2017	Issue for Comment	BK	KV
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1.0 EXECUTIVE SUMMARY

Site Name	Lockerbie Offtake
DNO	Scotia Gas Networks
LDZ	Scotland
Error Start Date	8th June 2016 @11:02
(Or) Last Good Date	
Error Corrected Date	27th January 2017 @13:24
Size of Error (over or under read)	1,835,649 Sm^3 under-registration (approx. 20.25 GWh)
Error Description	Meter temperature fault
Methodology	Correction of volumes using temperatures from nearby sites
Meter Type	Orifice
MER Unique Reference Number	SC014

2.0 ERROR DESCRIPTION

Lockerbie Offtake has one orifice meter stream with a GasPT for determination of density. On 27th January 2017 at 03:52 a meter suspect alarm was received and personnel were requested to site. A high temperature alarm was present on the flow computer caused by a fault on the surface-mounted Resistance Temperature Detector (RTD). The fault was resolved at 13:24 on 27th January 2017 when a (like-for-like) replacement RTD was installed.

On examination of the archived Reconciliation by Difference (RBD) data files it became apparent that the temperature reading had not been reading accurately since the previous annual T/PR/ME/2 maintenance on 8th June 2016 at approximately 11:00 and over time the recorded temperature had drifted up to the high alarm point.

3.0 METHODOLOGY

There is no other recorded temperature measurement at Lockerbie Offtake. Temperature measurements from nearby sites (refer to Figure 1) were looked at to see if there was any correlation. These were taken from Langholm, Nether Howcleugh and Wetheral (NGN) offtakes for the period (February 2017) after the temperature problem had been resolved. Low flow rate periods were filtered as the temperatures recorded can be significantly impacted by solar and other effects.

Site	Mean Bias	Standard Deviation
Langholm	-1.30	0.52
Nether Howcleugh	+4.05	2.50
Wetheral	-1.47	0.54

Table 1 - Nearby Sites Temperature Comparison

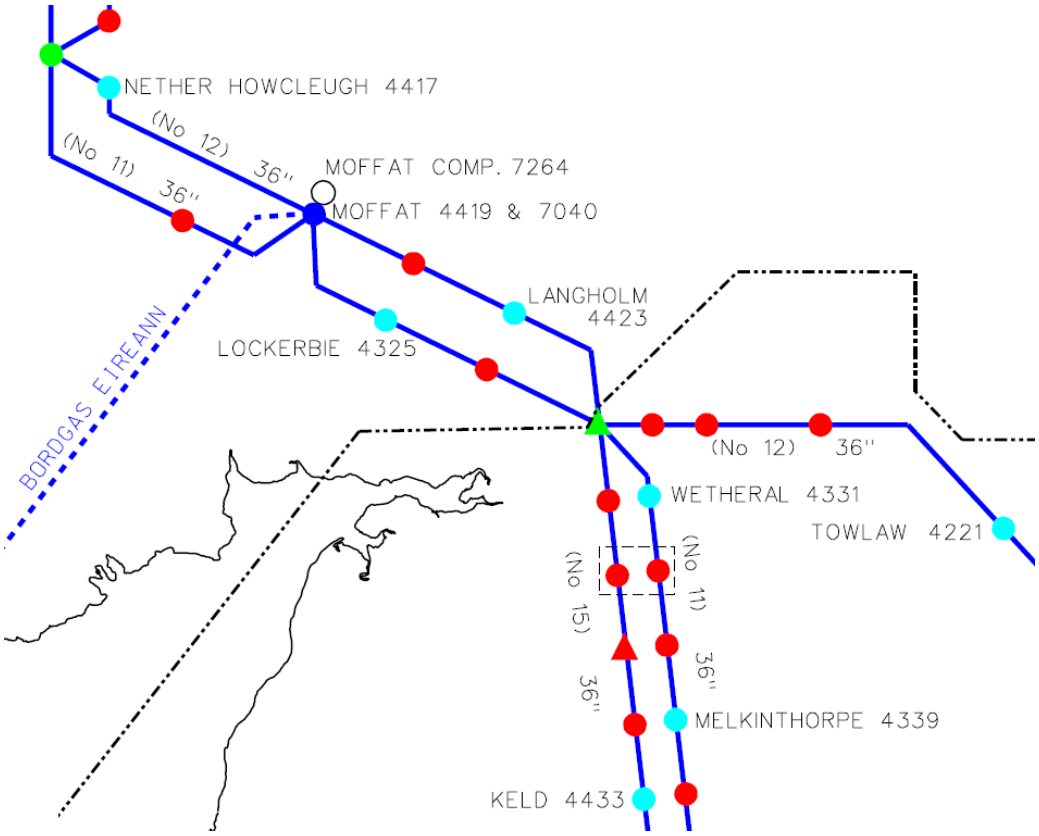

Figure 1 - NTS Diagram

The data in Table 1 demonstrates that the temperatures recorded at Lockerbie, Langholm and Wetheral show good correlation. Nether Howcleugh showed poor correlation because the temperature is recorded after controlled heating.

For the period of the error, the temperature data from Langholm and Wetheral was corrected for the mean bias and again low flow rate periods were filtered. The temperature error was calculated from the average of both Langholm and Wetheral or either one alone dependent on availability of a suitable measurement for comparison.

Figure 2 illustrates that the error was consistent (with a small drift of around 2 °C) from 8th June 2016 until 10th January 2017. The mean error for each month was calculated for this period and used to correct the measured temperature (refer to Table 2).

The characteristics of the error changed at 14:45 on 10th January 2017 as the error increased by ~10 °C and became more transient (refer to Figure 3). From this point until the error was resolved at 13:24 on 27th January 2017 the measured temperature was corrected using each individually calculated error. For the short periods where no suitable comparison was available, the temperature error was calculated from a 3rd order polynomial curve fit.

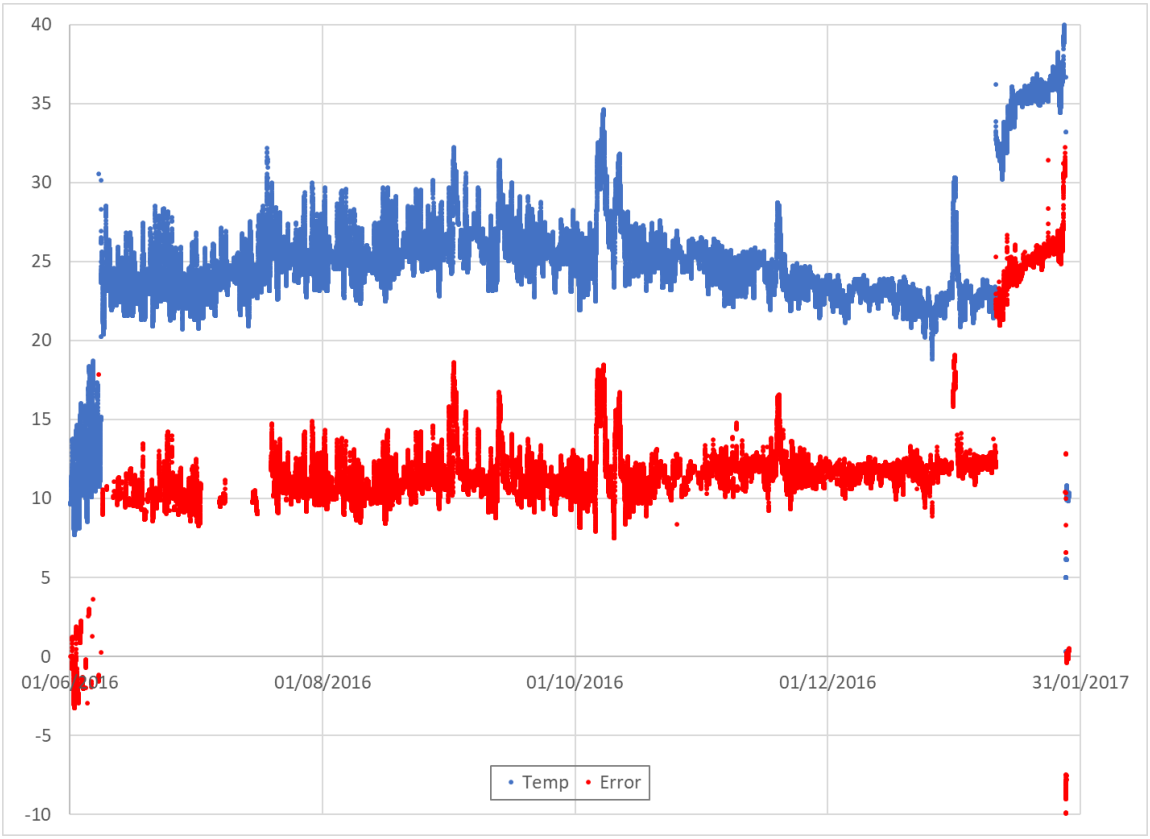

Figure 2 - Temperature Error (Entire Period)

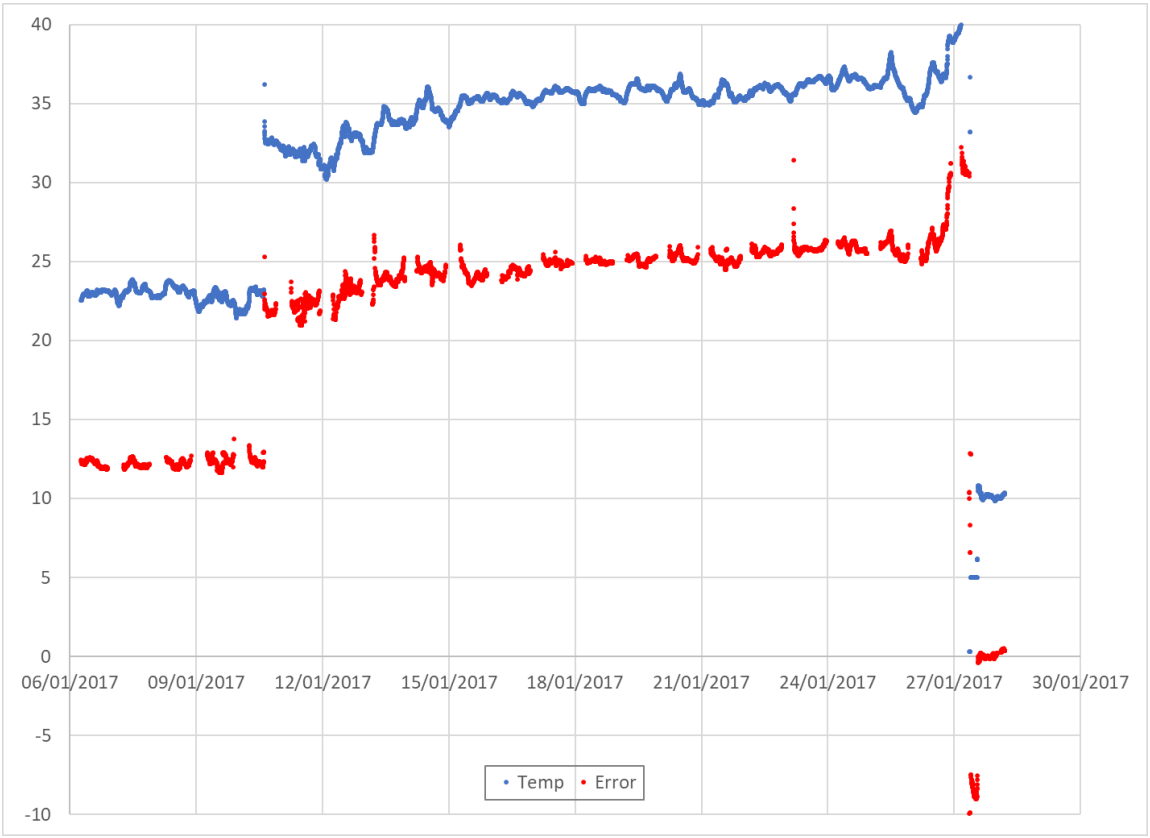

Figure 3 - Temperature Error (Transient Period)

Month	Mean Error	Standard Deviation
Jun-16	10.25	0.961
Jul-16	10.81	1.023
Aug-16	10.93	1.018
Sep-16	11.37	1.328
Oct-16	11.70	1.865
Nov-16	11.94	0.872
Dec-16	11.81	1.081
Jan-17	12.19	0.372

Table 2 – Monthly Temperature Errors

For the error period the corrected temperature, recorded on a 4-minutely basis, was recalculated using the temperature errors described above. Two sets of calculations (of density, flow rate and volume) were performed; one using the measured temperature and another using corrected temperature, the error being the difference between the two.

4.0 ERROR QUANTIFICATION

The error is calculated to be an overall under-registration of 1,835,649 Sm^3 for the period. The error should be corrected using the daily correction factors in Appendix A.

5.0 LEARNING

In this case of under-registration (of between approximately 3% and 8%) there is potential for under-odorisation.

The temperature alarm is a component of the meter suspect alarm which is inhibited when the stream is not flowing. The low and high temperature alarm limits are -10 °C and 40 °C, respectively. Between 1st May 2016 ad 30th April 2017 the real operating temperature was between 6 and 25 °C. Consideration should be given to setting the low and high temperature alarm limits at 0 °C and 30 °C, respectively. With these setting the high alarm would have been raised on 8th June 2016 and then again on 23rd June 2016.

As part of the T/PR/ME/2 validation a temperature spot check is performed, ideally after the rest of the temperature measurement loop has been verified. This check demonstrates that the temperature measurement loop is providing a sensible reading by comparison against a reference (typically a digital thermometer). Where a spare thermowell is not available (i.e. surface-mounted RTD or single measurement thermowell), it is typically necessary to disconnect and reconnect the RTD as part of this spot check and hence the reinstatement process can introduce an error as was likely to have occurred in this instance. Consideration should be given to installation of a spare thermowell for performing the temperature spot check. Another option would be to install a second (independent) temperature measurement that could be compared without the need to disconnect and reconnect the RTD. Care should be taken in the design not to introduce common mode failures.

6.0 REFERENCES

SGN HPMIS Database
NGN HPMIS Database
Omni Flow Computer Configuration Prints:
LOCV0609.PRN (9th June 2016)
MER_SC014_Comparison.xlsx – Site Temperature Comparison spreadsheet
MER_SC014_Error.xlsx – Temperature Error Calculation spreadsheet
MER_SC014_Recalc.xlsx – Volume Error Calculation spreadsheet

APPENDIX A – Daily Correction Factors

The error should be corrected using the daily correction factors (DCF) applied to the Gemini DVols (DVol) as detailed below.

Gas Day	DVol	DCF
08-Jun-16	0.11443	1.019169
09-Jun-16	0.11471	1.029014
10-Jun-16	0.11239	1.028796
11-Jun-16	0.12318	1.029670
12-Jun-16	0.10289	1.029371
13-Jun-16	0.11043	1.029244
14-Jun-16	0.12341	1.029066
15-Jun-16	0.12676	1.028202
16-Jun-16	0.13824	1.028176
17-Jun-16	0.13693	1.028788
18-Jun-16	0.13146	1.028256
19-Jun-16	0.11243	1.028468
20-Jun-16	0.12166	1.028486
21-Jun-16	0.13354	1.028461
22-Jun-16	0.12507	1.028528
23-Jun-16	0.11795	1.028398
24-Jun-16	0.1112	1.029016
25-Jun-16	0.11761	1.028377
26-Jun-16	0.10737	1.028501
27-Jun-16	0.10975	1.029018
28-Jun-16	0.13818	1.029284
29-Jun-16	0.15166	1.029350
30-Jun-16	0.13653	1.029398
01-Jul-16	0.14718	1.031564
02-Jul-16	0.13687	1.031438
03-Jul-16	0.12842	1.031178
04-Jul-16	0.13309	1.031355
05-Jul-16	0.13368	1.030931
06-Jul-16	0.15722	1.030813
07-Jul-16	0.12989	1.031203
08-Jul-16	0.13095	1.030923
09-Jul-16	0.12987	1.030582
10-Jul-16	0.11284	1.030713
11-Jul-16	0.12115	1.030779
12-Jul-16	0.14052	1.030400
13-Jul-16	0.1238	1.030587
14-Jul-16	0.12585	1.029958
15-Jul-16	0.13573	1.030544
16-Jul-16	0.12454	1.030448
17-Jul-16	0.10265	1.030059
18-Jul-16	0.11379	1.029615

Gas Day	DVol	DCF
19-Jul-16	0.11129	1.029096
20-Jul-16	0.119726	1.030084
21-Jul-16	0.12331	1.030467
22-Jul-16	0.10288	1.030409
23-Jul-16	0.11246	1.030074
24-Jul-16	0.09394	1.030273
25-Jul-16	0.09583	1.030329
26-Jul-16	0.11206	1.030311
27-Jul-16	0.10887	1.029894
28-Jul-16	0.12419	1.030062
29-Jul-16	0.1196	1.029622
30-Jul-16	0.11952	1.030202
31-Jul-16	0.0919	1.030208
01-Aug-16	0.1165	1.030067
02-Aug-16	0.11579	1.030412
03-Aug-16	0.13225	1.030654
04-Aug-16	0.11328	1.030232
05-Aug-16	0.13384	1.029964
06-Aug-16	0.1221	1.029509
07-Aug-16	0.10323	1.029283
08-Aug-16	0.11119	1.028705
09-Aug-16	0.13765	1.028977
10-Aug-16	0.15391	1.029724
11-Aug-16	0.14386	1.029374
12-Aug-16	0.1439	1.029453
13-Aug-16	0.14163	1.029629
14-Aug-16	0.11394	1.029849
15-Aug-16	0.11681	1.030014
16-Aug-16	0.11905	1.029853
17-Aug-16	0.12384	1.029837
18-Aug-16	0.12698	1.029994
19-Aug-16	0.13001	1.030050
20-Aug-16	0.14053	1.029933
21-Aug-16	0.13373	1.030246
22-Aug-16	0.12494	1.030466
23-Aug-16	0.12524	1.030485
24-Aug-16	0.12796	1.030692
25-Aug-16	0.13624	1.030652
26-Aug-16	0.12338	1.030812
27-Aug-16	0.12114	1.030560
28-Aug-16	0.10916	1.031088

Gas Day	DVol	DCF
29-Aug-16	0.10687	1.030559
30-Aug-16	0.12751	1.031203
31-Aug-16	0.11697	1.031164
01-Sep-16	0.12551	1.031402
02-Sep-16	0.11779	1.031229
03-Sep-16	0.11596	1.030602
04-Sep-16	0.07988	1.030235
05-Sep-16	0.10977	1.030215
06-Sep-16	0.10746	1.030972
07-Sep-16	0.09637	1.030919
08-Sep-16	0.10842	1.031641
09-Sep-16	0.12313	1.032755
10-Sep-16	0.11266	1.032625
11-Sep-16	0.10563	1.033213
12-Sep-16	0.1046	1.031805
13-Sep-16	0.11329	1.032241
14-Sep-16	0.1124	1.031748
15-Sep-16	0.11784	1.031765
16-Sep-16	0.12697	1.031787
17-Sep-16	0.13311	1.032453
18-Sep-16	0.12916	1.033102
19-Sep-16	0.12406	1.032553
20-Sep-16	0.14828	1.032481
21-Sep-16	0.15818	1.031767
22-Sep-16	0.16623	1.032308
23-Sep-16	0.15386	1.032709
24-Sep-16	0.15423	1.033037
25-Sep-16	0.13398	1.033545
26-Sep-16	0.17336	1.033114
27-Sep-16	0.17368	1.032925
28-Sep-16	0.17508	1.032906
29-Sep-16	0.16425	1.032713
30-Sep-16	0.19154	1.032874
01-Oct-16	0.18255	1.034309
02-Oct-16	0.16865	1.034446
03-Oct-16	0.18021	1.034629
04-Oct-16	0.17758	1.034825
05-Oct-16	0.17753	1.034698
06-Oct-16	0.18683	1.032523
07-Oct-16	0.19382	1.031767
08-Oct-16	0.17028	1.033237
09-Oct-16	0.18542	1.033912
10-Oct-16	0.19672	1.033311
11-Oct-16	0.21357	1.031978
12-Oct-16	0.21256	1.033084
13-Oct-16	0.21577	1.032991
14-Oct-16	0.22362	1.032701
15-Oct-16	0.21098	1.033588

Gas Day	DVol	DCF
16-Oct-16	0.20498	1.033974
17-Oct-16	0.19661	1.033752
18-Oct-16	0.23026	1.033915
19-Oct-16	0.22924	1.033310
20-Oct-16	0.22404	1.033048
21-Oct-16	0.24373	1.033208
22-Oct-16	0.25665	1.033657
23-Oct-16	0.24741	1.034160
24-Oct-16	0.24636	1.033430
25-Oct-16	0.2584	1.033290
26-Oct-16	0.22956	1.033827
27-Oct-16	0.22287	1.033884
28-Oct-16	0.21458	1.033642
29-Oct-16	0.229	1.033570
30-Oct-16	0.18594	1.033601
31-Oct-16	0.20417	1.033748
01-Nov-16	0.25208	1.034894
02-Nov-16	0.26974	1.034226
03-Nov-16	0.29866	1.033398
04-Nov-16	0.30037	1.033251
05-Nov-16	0.30519	1.034264
06-Nov-16	0.32103	1.034241
07-Nov-16	0.30168	1.033665
08-Nov-16	0.38456	1.033151
09-Nov-16	0.3452	1.033658
10-Nov-16	0.3414	1.033851
11-Nov-16	0.36318	1.033836
12-Nov-16	0.27091	1.034133
13-Nov-16	0.32558	1.033974
14-Nov-16	0.24795	1.034024
15-Nov-16	0.26941	1.034823
16-Nov-16	0.27466	1.034891
17-Nov-16	0.33417	1.034292
18-Nov-16	0.35163	1.033251
19-Nov-16	0.35453	1.033563
20-Nov-16	0.38871	1.034551
21-Nov-16	0.39263	1.034635
22-Nov-16	0.38309	1.033955
23-Nov-16	0.39002	1.033436
24-Nov-16	0.43051	1.032870
25-Nov-16	0.44265	1.033192
26-Nov-16	0.41092	1.034234
27-Nov-16	0.33409	1.034923
28-Nov-16	0.34852	1.034039
29-Nov-16	0.38474	1.033576
30-Nov-16	0.34466	1.033686
01-Dec-16	0.30693	1.033049
02-Dec-16	0.34057	1.033011

Gas Day	DVol	DCF
03-Dec-16	0.33871	1.033826
04-Dec-16	0.36499	1.034373
05-Dec-16	0.39857	1.033295
06-Dec-16	0.37861	1.034362
07-Dec-16	0.30166	1.034217
08-Dec-16	0.26777	1.034316
09-Dec-16	0.26852	1.033574
10-Dec-16	0.28344	1.034156
11-Dec-16	0.29376	1.034654
12-Dec-16	0.28625	1.033596
13-Dec-16	0.32545	1.034263
14-Dec-16	0.28382	1.034211
15-Dec-16	0.29245	1.034238
16-Dec-16	0.3054	1.034332
17-Dec-16	0.34985	1.034760
18-Dec-16	0.29837	1.034385
19-Dec-16	0.30601	1.034003
20-Dec-16	0.3562	1.033852
21-Dec-16	0.35794	1.033788
22-Dec-16	0.35182	1.034387
23-Dec-16	0.33373	1.034866
24-Dec-16	0.30328	1.035149
25-Dec-16	0.2344	1.034969
26-Dec-16	0.28988	1.034480
27-Dec-16	0.3145	1.033976
28-Dec-16	0.30837	1.034143
29-Dec-16	0.30003	1.034170
30-Dec-16	0.27851	1.034486
31-Dec-16	0.25357	1.032612
01-Jan-17	0.2872	1.035742
02-Jan-17	0.312	1.035569
03-Jan-17	0.32727	1.034924
04-Jan-17	0.34742	1.034802
05-Jan-17	0.40748	1.034287
06-Jan-17	0.34119	1.034659
07-Jan-17	0.29532	1.034999
08-Jan-17	0.27143	1.035905
09-Jan-17	0.30483	1.036193
10-Jan-17	0.32332	1.050870
11-Jan-17	0.34063	1.064253
12-Jan-17	0.38717	1.064904
13-Jan-17	0.40819	1.067213
14-Jan-17	0.37741	1.068311
15-Jan-17	0.31649	1.068999
16-Jan-17	0.2838	1.069598
17-Jan-17	0.29871	1.070476
18-Jan-17	0.29288	1.070580

Gas Day	DVol	DCF
19-Jan-17	0.30778	1.070998
20-Jan-17	0.32789	1.069949
21-Jan-17	0.34955	1.069078
22-Jan-17	0.34766	1.069957
23-Jan-17	0.37707	1.070615
24-Jan-17	0.32789	1.073342
25-Jan-17	0.32157	1.073949
26-Jan-17	0.36244	1.078216
27-Jan-17	0.39903	1.012708