British Gas Comments and Questions on Kelton Engineering Draft SMER

13th September 2013

These comments and questions are associated with the draft SMER produced by Keith Vugler of Kelton Engineering, Report Ref: NK3177-001.

The GL Noble Denton report, detailed within the Executive Summary, the estimated size of the error based upon the correction factors used. It would be useful if your report could provide a similar indication of error size.

KV Response (1);

I will include the estimated size of the error (GW/h) as requested within my final report.

General Comments & Questions

- The position of the orifice plate has not been confirmed, it has been derived from the measurement errors. This approach has a weakness in that there may have been other errors present that we do not know about. i.e. just because there is a flow step of "approx." 30% or 50% at the time does not mean it is all attributable to the orifice plate position. These estimated "flows" are misleading as they are used as targets.

  KV Response (2);

  I agree that the whole issue surrounding "what constitutes" the most representative orifice plate positional data to use within the review is a "weakness" due to the fact that there are no definitive site records that confirm the "as left" orifice plate position(s).

  I cannot do anything to change this. What I can do is make an informed judgement (as I shared with you in my presentation of 20th August) given the "value" of the site test results, the CFD supporting data and my practical experiences.

  I assume that reference of the "flow step" is being made to figures 3.4, 3.6 and 3.7 of my report. As you quite rightly recognise, these graphs represent just an "estimate" of the errors (as provided by "real time" 4 minute site data) and at no stage has any of this data been used within the error calculations. I can confirm that they have not been used as targets for site testing and certainly not misleading. The site test results (which are the values used in the error calculations and supported by CFD analysis) have been generated entirely independently in accordance with the Site Test Procedure detailed within section 5.3 of my report and the subsequent results obtained within section 6.0.

The ability to confirm that there was no additional sources of "measured" error other than orifice plate position can be supported by the results of the completed ME2 calibration records as referenced below. By process of elimination, if all system calibrations were found to be correct then the orifice plate position is very much the significant factor!

"As Found" ME2 Calibration Summary (21st July 2010) Covering Operational Period of SMER Period 1 (as an example);

SUMMARY SHEET

Scotia Network	Scotland
Site	ABERDEEN
Single stream site Y/N	Yes
Flow Computer Tag No.	FQ-1
Flow Computer Ser No.	62850

Meterlog Before	Meterlog - complete before commencing maintenance, daily.
Meterlog After	Meterlog - complete after maintenance, daily.

Test relevant to this site Y/N	Stream 1 Forms	Stream 2 Forms	Status	Date	Tested By
Yes	CP1a		Pass	21-Jul-10	Peter McQueen.
No	N/a		N/a	N/a	N/a
Yes	CP2a		Pass	21-Jul-10	Peter McQueen.
		N/a	N/a	N/a	N/a
No	N/a		N/a	N/a	N/a
		N/a	N/a	N/a	N/a
No	N/a		N/a	N/a	N/a
		N/a	N/a	N/a	N/a
Yes	CP3a		Pass	22-Jul-10	Peter McQueen.
No	N/a		N/a	N/a	N/a
Yes	CP4a		Pass	21-Jul-10	Peter McQueen.
		N/a	N/a	N/a	N/a
Yes	CP4b		Pass	21-Jul-10	Peter McQueen.
		N/a	N/a	N/a	N/a
Yes	CP4c		Pass	21-Jul-10	Peter McQueen.
		N/a	N/a	N/a	N/a
Yes	CP4d		Pass	21-Jul-10	Peter McQueen.
		N/a	N/a	N/a	N/a
No	N/a		N/a	N/a	N/a
		N/a	N/a	N/a	N/a
Yes	CP5		Pass	21-Jul-10	Peter McQueen.
		N/a	N/a	N/a	N/a
Yes	CP6a		Retest	21-Jul-10	Peter McQueen.
Yes	CP6b		Pass	21-Jul-10	Peter McQueen.
Yes	CP6c		Pass	21-Jul-10	Peter McQueen.
Yes	CP7		Pass	21-Jul-10	Peter McQueen.
		N/a	N/a	N/a	N/a
Yes	CP8a		Pass	21-Jul-10	Peter McQueen.
No	N/a		N/a	N/a	N/a
Yes	CP9		Pass	27-Jul-10	Peter McQueen.
Yes	CP10		Pass	22-Jul-10	Peter McQueen.
		N/a	N/a	N/a	N/a
Yes	CP11a		Pass	22-Jul-10	Peter McQueen.
		N/a	N/a	N/a	N/a
Yes	CP11b		Pass	22-Jul-10	Peter McQueen.
		N/a	N/a	N/a	N/a
Yes	CP11c		Pass	22-Jul-10	Peter McQueen.
		N/a	N/a	N/a	N/a
No	N/a		N/a	N/a	N/a
		N/a	N/a	N/a	N/a
Yes	CP13		Pass	27-Jul-10	Peter McQueen.
		N/a	N/a	N/a	N/a
Yes	CP14a		Pass	27-Jul-10	Peter McQueen.
		N/a	N/a	N/a	N/a
No	N/a		N/a	N/a	N/a
		N/a	N/a	N/a	N/a
No	N/a		N/a	N/a	N/a
		N/a	N/a	N/a	N/a
No	N/a		N/a	N/a	N/a
Yes	CP16		Pass	27-Jul-10	Peter McQueen.

Note: Test CP6a is an internal site control volume signal DAC and therefore not applicable to any flow computer calculation function.

The view of the ITE is that the site test results support the estimated "real time 4 minute data graphs" rather than the other way round which provides significant confidence in the results obtained.

- There is no clarity provided as to why the plates were positioned at 99985 and 99950, although the ITE has made a statement as to why this occurred, there is no statement from the individuals concerned as to why they left the plates in those positions. The position of the plates remains a real concern and weakness in the report, based upon assumption rather that fact or evidence.

  KV Response (3);

  My response (2) refers with regard the orifice plate positional clarity (or lack of should I say)!

  I have acknowledged within my report and also during my presentation to you on 20th August that there is no definitive site records that confirm the "as left" orifice plate position(s) – certainly not for the 99985 case. I have not included a "statement" from the individuals concerned as there isn't any to include (just vague verbal exchanges).

  I would disagree that the orifice plate positional data has been based solely on assumption as there is good "practical" supporting data which I have detailed on pages 9 and 12 of my report.

  I have however, with regard the 99950 orifice plate position, a copy of some text which was "officially" reported by the Senior Network Technician to an internal SGN investigation which I include over page for your reference. Hopefully it will help support my observations detailed on page 12 of my report.

  I will additionally include this within my final report.

The initial feedback from the Senior Network Technician on site on 10th August is contained within an email dated 11th August 2010 as follows:-

> Further to our telephone conversations yesterday my findings were as follows.
>
> After investigating all other metering equipment / flowcomputer configuration etc. and deciding all was in order with them I turned my attention to the orifice plate. I already suspected the orifice plate as the problems on site appear to have started from the 27th July; the orifice plate was changed that day. Unfortunately due to site conditions we could not flow the site on completion of this work.
>
> When the orifice plate was removed on the 27th the mechanical team had noted the counter on the orifice plate carrier was reading 9995, the new plate was returned to this position. Yesterday we took the metering off line and removed the orifice plate for inspection, all was in order and the plate was replaced. Instead of returning the plate to 9995 as before I asked the mechanical guys to wind the plate fully down to 0000. I reinstated the metering and checked the DP across the head cells at this point. The valves were in DVC and frozen in local control therefore the flow remained constant throughout these tests. With the orifice plate at 0000 the DP was approx. 54mB and the flow 1.4 MSCMD. I asked the mechanical team to wind the plate back up to 9995 (I am not sure how many turns this took as I was inside at the flow computer at this time) the DP went back down to 6.1 mB and the flow to 0.5 MSCMD. I asked for the plate to be returned to 0000 and called you at this stage. The plate remains in this 0000 position.
>
> When the mechanical team replace the plate at this site they follow the instructions as stated on the carrier plate and they wind it down to the required position only i.e. 9995, they do not take right down to the bottom and back up to 9995.
>
> Hope this clarifies what was found yesterday.
>
> Yours.
>
> Senior Network Technician (Instrumentation)

Other conversations confirm that the orifice plate was positioned at a counter reading of 99950 rather than 9995 as specified in this email.

It is understood that the Mechanical Operative reported that the orifice plate elevator screw turned 14 times when lowering the orifice plate from a counter reading of 99950 to 00000 when correcting the fault on 10th August 2010.

Subsequent interviews were held with the Mechanical Operatives who undertook the orifice plate changes on 21st July 2009 and 27th July 2010. The Operatives were not able to confirm the counter reading on the orifice plate carrier at the end of the operations on 21st July 2009 or at the start of the operations on 27th July 2010. However, there is some confidence that the orifice plate was left at a counter reading of 99950 on 27th July 2010.

Further investigations were held on site on 6th September 2010 and these are detailed in Appendix 2.

From the evidence available it is quite clear that the orifice plate was located at a counter reading of 99950 between 27th July 2010 and 10th August 2010.

- The error for the insertion of the plates should be used and not the removal (this has been done) as both plates were being inserted and there is hysteresis in the winding mechanism.

  KV Response (4);

  As recognised within the comment above, this has been the option included within the review. Further justification has been included within the TMI response to Scottish Power.

- At the 99950 position there is considerable spread in the errors about 63% to 75%, depending on the flow rate, this spread of 10% or so has not been explained.

  KV Response (5);

  I agree that there is considerable spread in the errors at this position. These are the results of the site tests and effectively "they are what they are"! My thoughts are that Tests 1, 9 and 11 were extremely low flow tests (2 -4 mbar) and would obviously be at a significantly high measurement uncertainty. These 3 tests contribute to the most significant departures within the results spread and additionally are <u>not</u> supported by the CFD results. Therefore (as detailed within section 7.6 of my report) these tests can be considered unrepresentative and the spread of results then becomes typically 2.2% (70.55% to 72.75%), which is much more acceptable.

- The error must be determined by the errors at flow rates which are the closest to that on each day as there are differences in the errors wrt flows. The errors should not be averaged into a single figure to be applied to all of the days.

  KV Response (6);

  I am of the opinion that this is exactly what has been done in that 2 correction factors for the 99985 position (derived from the low & medium site test results) have been applied to the appropriate average daily flow figure.

  This has been detailed within section 9.0 of my report and supported by tabulated reference data supplied with Appendices A & E.

- The low differential pressure (DP) recorded should be used and not excluded, it does raise the question of whether the facility is being used outside of the agreed uncertainty and therefore commercial agreed operational envelope. It could be argued that no correction is applied as it has not been operated correctly. We can get into a situation where the uncertainties are so high that a random guess is as good as a calculated value.

  KV Response (7);

  The boundaries of the ITE scope are being exceeded here with the incorporation of commercially related issues!

  In accordance with the deliverable of this review, I have calculated correction factors (as detailed within section 9.0) that should be applied as per the recommendations of my report to the associated daily GEMINI daily totals.

  All site test data which has been appropriately supported by CFD analysis (irrelative of ΔP value) has been used within the calculation of the correction factors which I believe to be fully traceable through the sections incorporated within my report.

Detailed Comments & Questions

1. No report reference:

Please confirm the dp low-flow cut off and that all values above this are used contractually for billing purposes and are therefore valid?

KV Response (8);

From notes made during the site testing activities, the value recorded for the ΔP cut-off setting was 0.9 mbar.

I can only assume (as flow rate will be registered above this setting and subsequently totalised) that it will provide the daily flow total resident within GEMINI accordingly.

2. Section 7.2, Page 53: For the SMER period (1) 99985 counter reading plots, the three most obvious low error values are those representing the low flow test data (at typically 13- 15 mbar). **However, the CFD results for these test points (section 8 refers) agree favourably and for that reason there is no justification to exclude these site test values from further review.**

Please confirm that the Low flow tests and associated corrections are justified

KV Response (9);

As all the site flow tests for the 99985 counter reading agree favourably with the CFD analysis there is no justification to exclude them, therefore they are all considered to be justifiable.

3. Section 7.2, Page 53: For the SMER period (2) 99950 counter reading plots, the two most obvious low error values (Tests 9 & 11) are those again, representing the low flow test data (at typically 2-4 mbar). However, in this case the CFD results for these test points (section 8 refers) record a significant discrepancy which potentially casts doubt over the acceptability of these site test values.

   Whilst not as obvious, the same can be said of the SMER period (2) Test 1 (medium pressure/low flow) which can be seen to fall "typically" within the main spread of the data set but much higher (in relation) to the other flow results. As in (2), the CFD result for this test point (section 8 refers) records a significant discrepancy which again, potentially casts doubt over the acceptability of this site value.

You have noted "significant discrepancies", and in terms of dp measurement uncertainty this may be correct, however the Absolute error between these site tests and the CFD is very small, <1m barg and as this SMER is being progressed an "on-balance" and "best endeavours" approach, where little has been proven to be is certain, is this "significant discrepancies", statement valid?

KV Response (10);

I agree that the "absolute error" for these test points against CFD analysis results is small but this also applies to all other test points within the review process. The fact that at such low ΔP the "relative error" is significantly higher does not, in my opinion, deem it different from other results.

I will however, when I meet with the other ITE to agree on the Combined Summary Report (once my individual report is finalised), discuss this issue to ensure he is of the same opinion.

4. Section 7.3, Page 53: It was noted that the flow stability (difference between the test start and finish flows) observed throughout individual tests, varied on occasions and therefore had an effect on the value of reference flow rate used within the calculation of test errors (Section 5.4 refers);
   Test 1 ≈4%
   Test 2 ≈4%
   Test 3 ≈7%
   Test 4 ≈4%
   Test 6 ≈3%
   Test 7 ≈12%
   Test 8- ≈4%
   Test 9- ≈1%
   Test 10- ≈11%
   Test 11- ≈8%

Please can the author confirm whether any of the instabilities have included within any of the uncertainty calculation performed?

KV Response (11);

Certainly the stability achieved for some of the site testing was disappointing. However, the CFD activity was commissioned to support this specific purpose and as detailed within my report is very favourable even when the test instability was calculated to be high.

It was not possible to detect at which stage of the individual flow test period the instability occurred or the rate at which it diminished or increased.

The methodology in which the site testing error results were derived (as detailed with section 5.4 of my report) was to principally recognise the instability effects seen during the site testing which would appear to be appropriate as the CFD analysis supports accordingly.

5. Section 7.5, Page 53: **7.5 Test Summary – SMER Period 1 (Counter Reading 99985)**
   From review of the test results, it can be seen that a majority of the test results follow a very similar response profile and show good agreement with the CFD modelling (section 8 refers). Therefore, there is no reason to disregard any of the site testing results from this review. Interestingly, Tests 9 and 11 (low flow A & B) are the most remote which could be due to the low differential pressures seen at this test point (≈15 bar).

AND

Section 7.4, Page 53: **7.6 Test Summary – SMER Period 2 (Counter Reading 99950)**
From review of the test results, it can be seen that 70% of the test results follow a similar response profile and good agreement with the CFD modelling (section 8 refers) with the following exceptions;
Test 1 – Medium Pressure / Low Flow
Test 9 – Low Pressure / Low Flow
Test 11 – Low Pressure / Low Flow

As these site tests were performed at such high measurement uncertainty due to the extremely low differential pressures (2-4 mbar) and the CFD results for these test points (section 8 refers) record such a significant discrepancy, it is the opinion of the Independent Technical Expert that these site test values are considered unrepresentative for use within the final correction factor calculation.

Please further detail why Site Tests 1, 9 & 11 have been ruled out, especially when consideration to the Absolute errors being so small, the results being obtained at typical site conditions?
Please detail on what basis these results have been labelled as "outliers", especially as not enough tests were performed for this to be proven?

KV Response (12);

I have been very careful not to label tests 1, 9 and 11 as "outliers" as your comment suggests for the same reason as is prescribed above in that there is not sufficient test data for this to be proven – so on this we are agreed!

Tests 1, 9 and 11 have been considered unrepresentative based "purely" on the significant "relative" errors when referenced to the CFD results.

My response (10) refers in that whilst I am of the opinion this is the correct methodology to incorporate, I will, when I meet with the other ITE to agree on the Combined Summary Report (once my individual report is finalised), discuss this issue to ensure he is of the same opinion.