GL Noble Denton

Technical Note Number: 14426
Issue: 1.0
Date: 18th September 2013

Response to British Gas Comments and Questions (Dated 13th September 2013) on GL Noble Denton Draft SMER

General Comments & Questions

Q1. 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.

A1. It was not possible to confirm the counter reading of the orifice plate between 21st July 2009 and 27th July 2010 because no records were kept of the counter reading. The report has provided several pieces of evidence (see section 3.1) which corroborate each other. These have been presented as evidence of the most plausible case for the position of the orifice plate based on the information available. There is no evidence to suggest that any other errors were present. The counter reading of the orifice plate between 27th July 2010 and 10th August 2010 was confirmed by interviews with mechanical operatives and supported by other evidence presented in the report (see section 3.2).

Q2. 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.

A2. The reason for the plates being positioned at counter readings of 99985 and 99950 is superfluous. Explanations have been explored however the mechanical operatives were unable to recollect events. Evidence for the position of the plates is discussed above (see A1).

Q3. 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.

A3. The error for the insertion of the plates has been used.

Q4. 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.

A4. The report states that 'the standard deviation is higher at a counter reading of 99950, the largest deviations being at lower flow rates. This is to be expected due to the high uncertainty levels in the DP measurement at low DPs. A typical DP measurement uncertainty profile is provided in Appendix C. This does not take into account the increased unsteadiness of the DP signal caused by the eccentricity.' At the 99950 counter reading the plate is far removed from its normal operating position and the differential pressures are much lower than under normal operation. The spread is due to the low DPs and high uncertainty. Removal of the lowest DPs can be seen to reduce this spread (or standard deviation) significantly.

Q5. 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.

A5. There is no significant change in the error with respect to flow rate, as shown in Figures 50 and 53. The coefficients of determination are 0.143 and 0.000 for the 99985 and 99950 datasets respectively. The correlation of each dataset is not significant based on a two-sided T-test with 95% confidence interval.

Q6. 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.

A6. The low DP results, between 1.40 mbar and 3.07 mbar, have been excluded based on statistical analysis. When these results are removed the standard deviation is significantly reduced, hence the accuracy of the overall result is significantly improved. The ITE cannot comment on the commercial agreement.

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Detailed Comments & Questions

Q1. Section 1, Page 7. The report states: "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." Therefore claims that [were] made during the two SMER presentations, that the orifice counter referenced position was confirmed by testimony, needs further clarification? The position of the orifice plate is critical to enabling accurate assessment of the error.

A1. The 99950 counter reading was confirmed by testimony; the 99985 counter reading was not. The methodology presentation (16th July 2012) refers to this in slide 8 (and 14). The report presentation (20th August 2013) refers to this in slide 19 (also 6, 13, 45 and 46).

Q2. Section 2.5, Page 26. The report states: "This pressure range was deemed to be acceptable as it covered the vast majority of the data (>85 %) as indicated in Table 4 (and on later analysis the error was shown to be insensitive to pressure)." On what basis, knowledge or experience was this deemed "acceptable"?

A2. The pressure range covered >85% of the operational data however at the time of site testing the ITE was not fully satisfied with this range. Preliminary analysis of the results indicated that the error was insensitive to flow and pressure. Following the CFD analysis, which supported this finding, the option of further site testing was seen as unnecessary and the pressure range was deemed acceptable.

Q3. Section 2.6.2, Page 39. The report shows that the CFD broadly validities the practical tests, however the errors, with a range of 6.1% tests do appear scattered. Were pre-test acceptance criteria set? What levels of error would be seen as unacceptable?

A3. No CFD analysis of this nature has been carried out before therefore expectations were based on generic criteria. The pre-test acceptance criteria were that the results should be within the combined uncertainty of the experimental data and CFD analysis. The uncertainty in the experimental data was largely due to the differential pressure measurement (which varies) although other factors were considered. The CFD analysis uncertainty was expected to be within around ±1% for very good results or ±3% for satisfactory results.

Q4. Section 2.6.2, Page 39 etc. The report shows a number of DP measurement uncertainties, for instance for Test 1 there is a dp of ~14mbar yet the DP measurement uncertainty is given as +/-5%, which appears high for such a nominal DP value. How have these values been calculated? And if it is correct then it must mean that the measurement station is operating outwith it's contactrual uncertainties also?

A4. The DP measurement uncertainty presented in Appendix C was used as a guide for the level of accuracy that could reasonably be expected from the experimental DP results. It was calculated based on a Honeywell STD120 DP transmitter; span = 0 to 100 mbar; URL = 1000 mbar; Reference accuracy = 0.075 %URL; taking into account pressure, temperature and 1 year stability effects. It is not a calculation of the uncertainty in volume measurement for Aberdeen Offtake. The ITE cannot comment on the commercial agreement.

Q5. Section 2.5.2, Page 27. The report states: Note: Test 5 was abandoned because the low pressure override was activated, affecting the flow rate. Therefore the results have not been included in the analysis. From this it can only be assumed that all the other test were deemed valid?

A5. This statement was included to clarify the numbering of the tests (i.e. Tests 1 to 11, without 5). No other tests were abandoned. No tests were carried out other than those 11 that have been referred to. The tests (except test 5) were deemed to be valid at the time of testing. Statistical analysis of the results shows that the results of the tests with lowest DPs were not as reliable as the other tests.

Q6. Section 2.5.2, Page 28-. The report states a number of rate drift, which include a number over 10% at the higher flow rates, which are deemed acceptable. Were pre-test acceptance criteria set? What levels of drift would be seen as unacceptable?

A6. Pre-test acceptance criteria were not set because this was not identified as a potential issue. The drift is caused by the imbalance between supply and demand and as such is linear. If the drift had caused the flow rate to move to a significantly different level (e.g. from a flow rate classed as high to a flow rate classed as medium) then it would have been considered unacceptable.

Q7. Section 2.1, Page 9. The report states: “low DP cut-off (0.9 mbar)”, Can it therefore be assumed that all differential pressures above this value are live in use and valid values, which were used as per the relevant contracts during the SMER for accountancy purposes. Can you please confirm that this is the case?

A7. The flow is registered and is accumulated on the totaliser only when the DP is above the low DP cut-off. The ITE can confirm that this is standard practice for Offtake orifice plate metering systems. The ITE cannot comment on the commercial agreement or the use for accountancy purposes.

Q8. Section 3, Page 49. The report states:“ The reduction in the standard deviation demonstrates that the two data sets are more reliable and support each other particularly well at DPs above 10 mbar.” Where does 10mbar come from? If the low flow data set is invalid due to it’s high standard deviation, on what basis are you stating this?
and/or please detail the uncertainty calculation you have used? How can you state that it is better to use the medium and high flow data sets, which are only applicable to their associated flowrates, then real data at the low flowrate cases, especially when this data is still supported by the CFD, when considering how small the absolution errors are?
Please kindly detail and include the low flow correction assuming the data is accepted, so that the review can make their own informed decision?

A8. The value of 10 mbar comes from a suitable cut-off point, between two data points, which has been used for clarity only. The statistical analysis showed a marked difference in the standard deviation of the experimental dataset at 99950 counter reading compared to the other datasets (3.1% vs. 0.7%). The analysis examined the effect of removing outliers starting with the lowest DPs, as these were the visible outliers. After removing the 4 lowest DP readings the standard deviation reduced from 3.1% to 0.4%. Removing further data points did not significantly reduce the standard deviation, e.g. removing the next lowest DPs (at the 99985 counter reading) reduced the standard deviation from 0.7% to 0.5%. There is a compromise to be made between reducing the standard deviation whilst maintaining a suitably sized dataset, therefore only significant reductions in standard deviation were considered. The points removed were between 1.40 mbar and 3.07 mbar. The next lowest DP point was 12.06 mbar therefore the cut-off has been described as 10 mbar for simplicity.
The error has been shown to be independent of flow rate and therefore the results for the medium and high flow datasets are applicable not only to their associated flow rates, but also to low flow rates. The low flow rate data that has been excluded has large associated uncertainties due to the DP measurement. It is supported by the CFD, but this takes into account the uncertainties. The errors between the experiment and CFD data are between 23% and 42% for three out of the four excluded data points.

Q9. Section 3.2, Page 49. The report states: "The on-site testing and CFD analysis show that the error is independent of process conditions and therefore a single value can be applied across the period." Within what un-biased uncertainty and with what confidence in % is this made?

A9. There is no significant change in the error with respect to flow rate, as shown in Figures 50 and 53. The coefficients of determination are 0.143 and 0.000 for the 99985 and 99950 datasets respectively. The correlation of each dataset is not significant based on a two-sided T-test with 95% confidence interval.

Q10. Section 3.2, Page 49. The report states: "The average error from the on-site testing was an under registration of 26.1 % with a standard deviation of 0.7 %. This results in a daily correction factor of 1.353066." How can you state that it is better to use the medium and high flow data sets, which are only applicable their associated flowrates, then real data at the low flowrate cases, especially when this data is still supported by the CFD?

A10. The error has been shown to be independent of flow rate and therefore the results for the medium and high flow datasets are applicable not only to their associated flow rates, but also to low flow rates. The low flow rate data that has been excluded has large associated uncertainties due to the DP measurement. It is supported by the CFD, but this takes into account the uncertainties. The errors between the experiment and CFD data are between 23% and 42% for three out of the four excluded data points. After removing the 4 lowest DP readings the standard deviation reduced from 3.1% to 0.4%.

Q11. Section 2.1, Page 9. The report states: "Based on this the unknown counter reading between 21st July 2009 and 27th July 2010 was estimated to be around 99984" And Section 2.2.1, Page 13. The report states that all orifice plate positions are stated with tolerances of A (vertical) +/- 0.5mm and B (horizontal) +/- 2mm And Section 2.3, Page 16. The report states: "Following this examination an explanation for the incorrect counter readings was sought. The data plate suggests that the fully inserted position should be at a counter reading of between 9995 and 0005 however the counter has five digits and the fully inserted position is exactly 00000. From this it can be seen that the four digit 9995 counter reading was likely to have been misinterpreted as a five digit reading of 99950. There was no evidence to support a counter reading of 99984 as estimated from the initial tests and flow profile analysis. However it was thought that the 99885 which is stamped in two locations on the carrier information plate could have been misread as 99985" And Section 2.3, Page 17. The name plate is clearly unreadable and open to mis-interpretation. The above are all examples of "On balance the best fit is", which is an approximation of unknown uncertainty, however you have thrown out the Low Flow test results based on high uncertainty?

A11. There is no question posed. The name plate is readable in good lighting conditions and the text has been provided in the appendix to aid the reader. It is not disputed that it is difficult to read and open to misinterpretation which is the basis of the error. The report has used the most appropriate data and methodologies to ensure that as accurate an error assessment of the "Measured Data" can be made in an economic and efficient manner reflecting the size of the error. The results at the lowest DPs have been excluded to make the assessment of the error more accurate, as is demonstrated by the significant reduction in standard deviation.

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