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Aberdeen SMER SC006

7th October 2013



Overview

- Comparison of Individual Reports
- Revised Methodology
 - Calculation of Reference Flow
- Error Quantification
 - Revised Results
 - Correlation Significance
- Summary of Error Periods

Comparison of Individual Reports

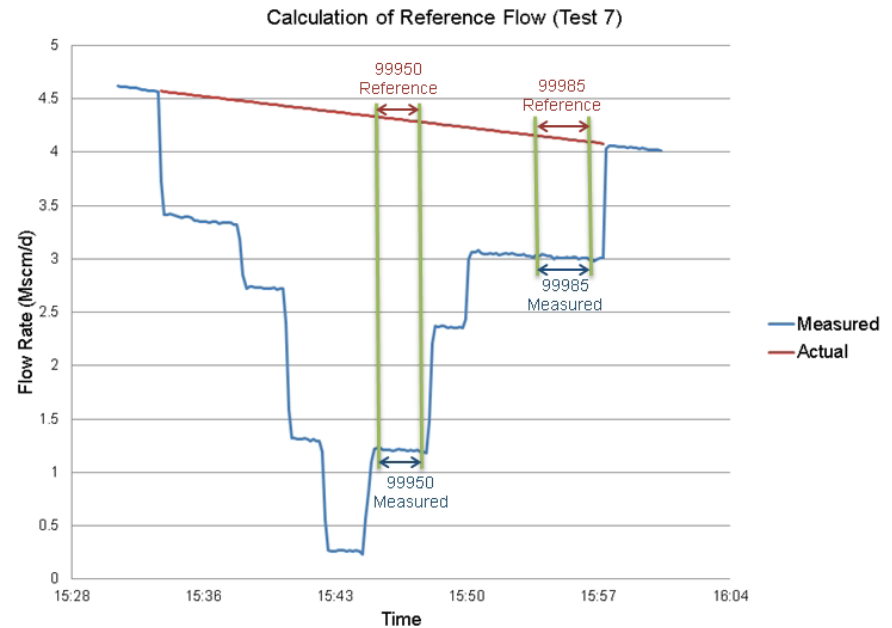
- Individual reports are largely supportive of each other
- Description of the error and evidence for counter readings are similar
- Minor differences in interpretation of stable test periods
 - ITEs reached agreement on data
- Difference in method for correction of flow rate instability
 - ITEs agreed that most appropriate method was linear correction using relevant timeframes for reference flow

Comparison of Individual Reports

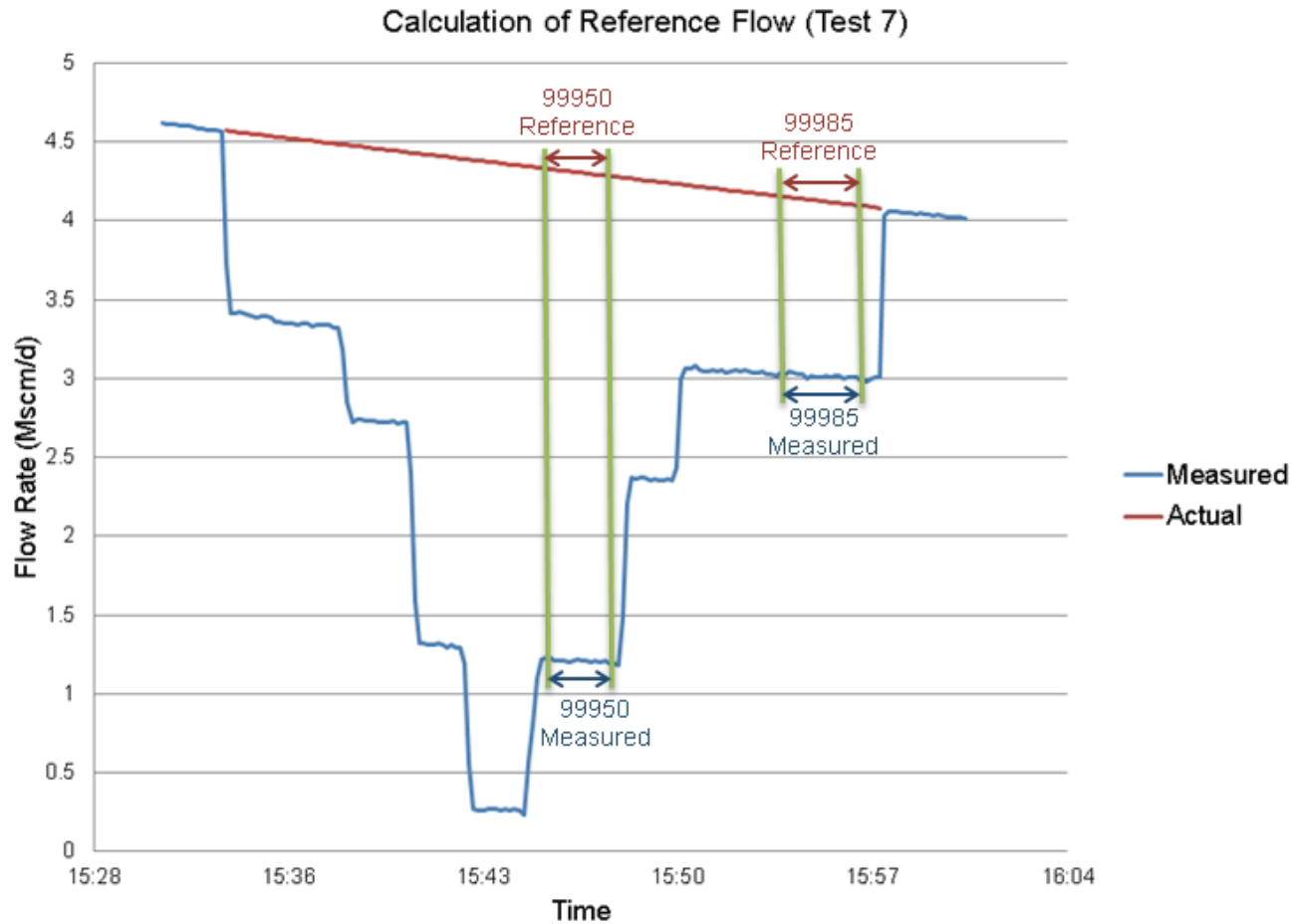
- Difference in excluded test results
 - ITEs agreed on exclusion of test 1, 9 and 11 results for 99950 counter reading
 - Based on comparison with CFD analysis
- Difference in treatment of errors (dependence on process conditions)
 - ITEs agreed that both methods were valid based on the results presented in each report
 - Results differed mainly based on method for correction of flow rate instability
 - ITEs agreed upon statistical analysis of correlation significance of revised results

Calculation of Reference Flow

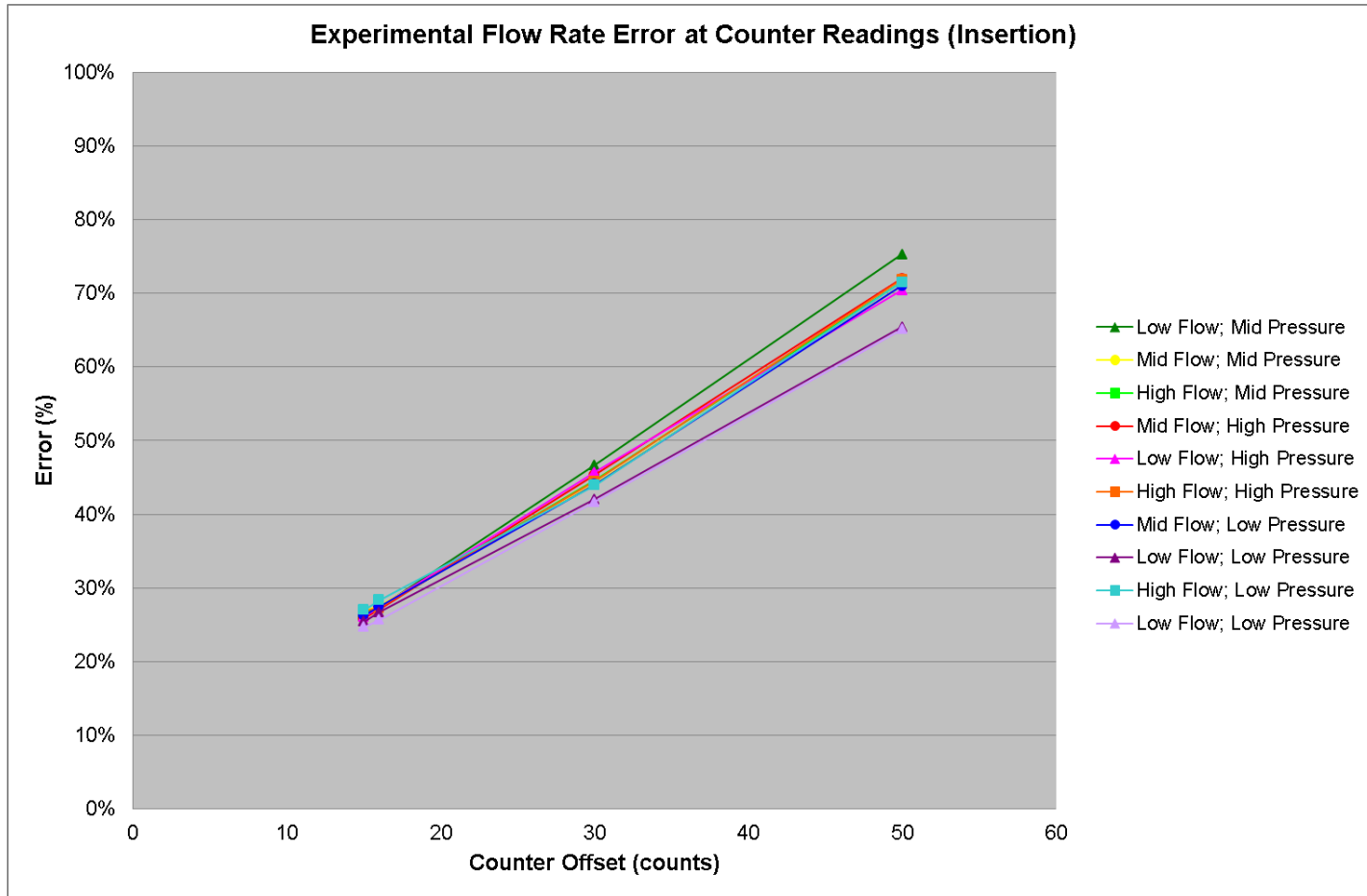
- Flow rate drift assumed to be linear over the duration of each test
- Start and end flow rates averaged from stable period (00000 counter reading)
- Linear interpolation carried out to produce reference flow rate
- Results for each counter reading referenced to the corresponding period of reference flow rate
- Experimental errors recalculated
- CFD errors recalculated
 - Referenced to experimental results



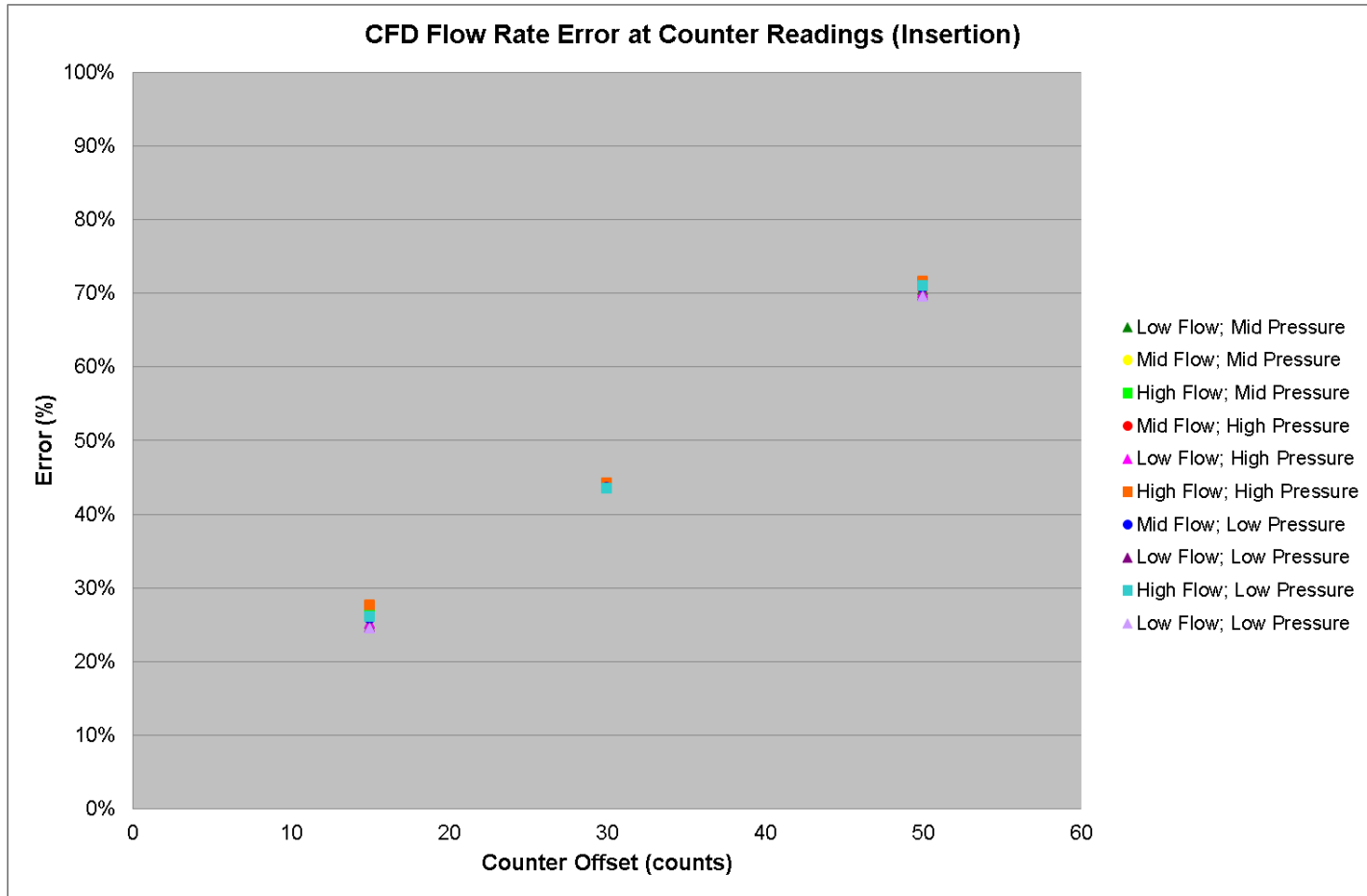
Calculation of Reference Flow



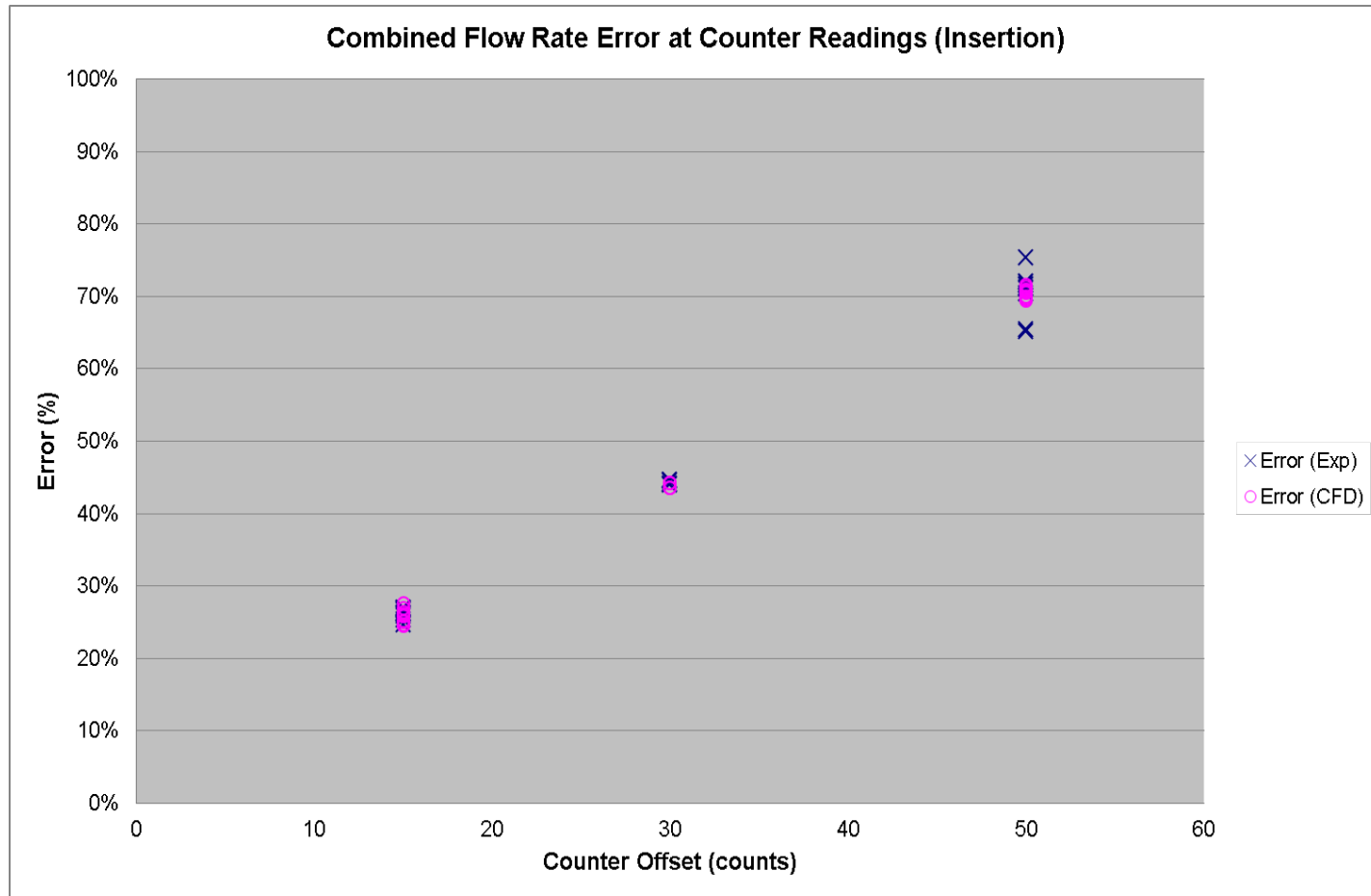
Results - Experimental



Results - CFD



Results - Combined



Results - Combined

Counter Reading	Experimental Error (%)		CFD Error (%)		Difference in Mean (% relative)
	Mean	Std. Dev.	Mean	Std. Dev.	
99985	26.2 %	0.7 %	25.8 %	1.0 %	-1.4 %
99950	70.6 %	3.1 %	70.6 %	0.7 %	0.0 %

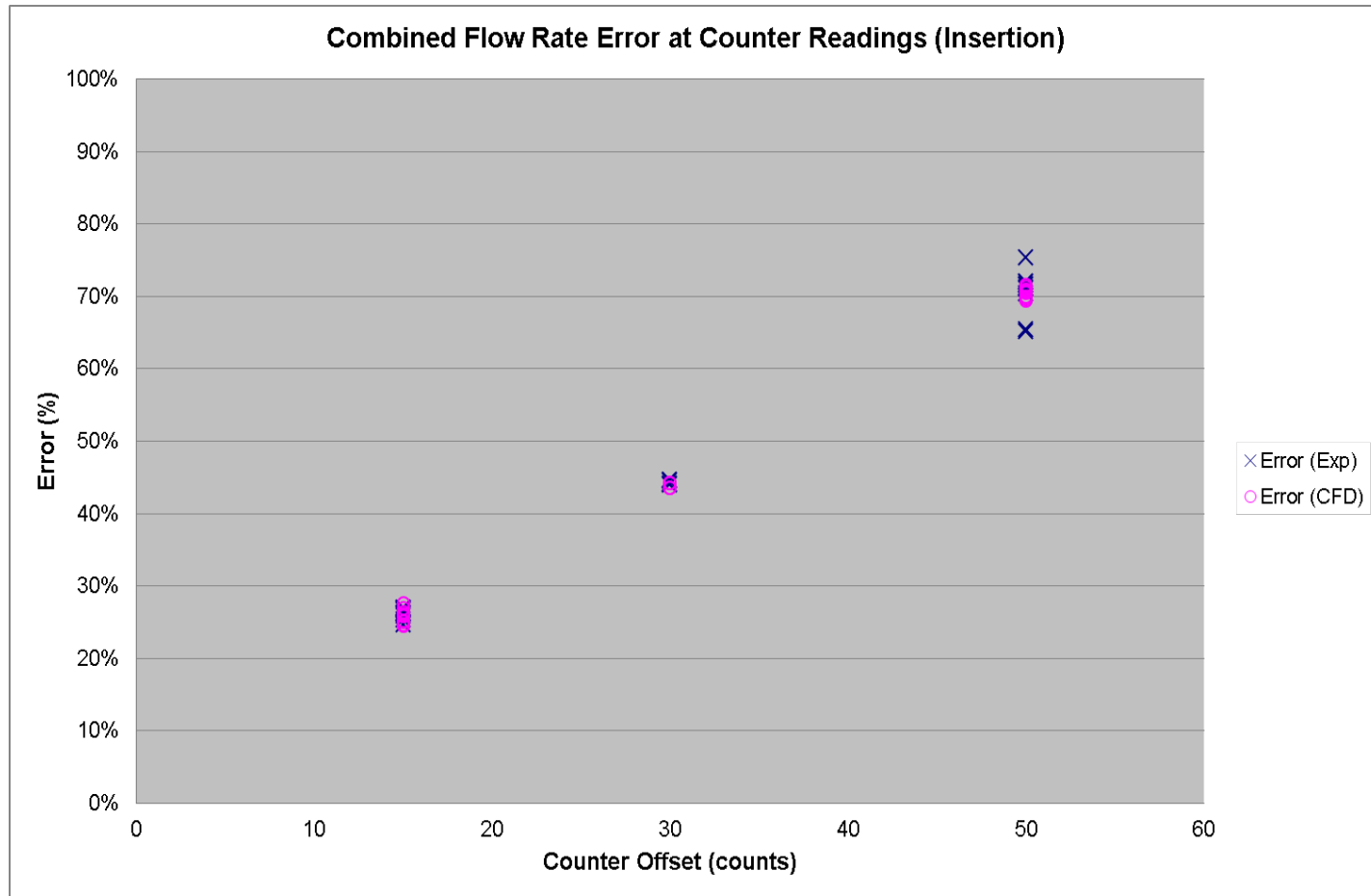
- High standard deviations at low DPs
 - Large discrepancies between experimental and CFD results for tests 1, 9 and 11 at 99950 counter reading

Results - Combined

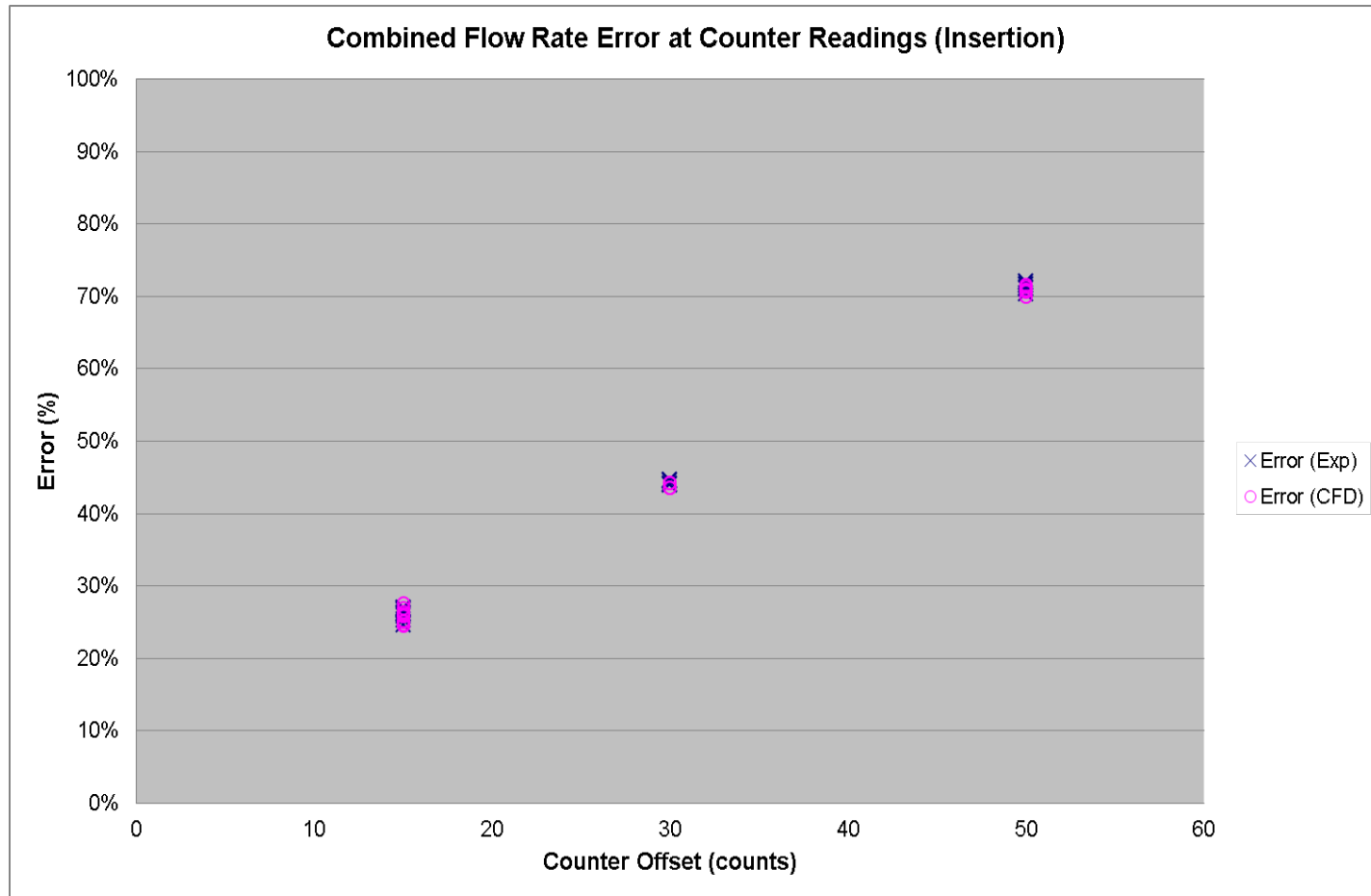
Counter Reading	Experimental Error (%)		CFD Error (%)		Difference in Mean (% relative)
	Mean	Std. Dev.	Mean	Std. Dev.	
99950 (All)	70.6 %	3.1 %	70.6 %	0.7 %	0.0 %
99950 (Exclusions)	71.4 %	0.6 %	70.9 %	0.5 %	-0.7 %

- Excluding results from tests 1, 9 and 11 at 99950 counter reading significantly reduces standard deviation
 - Demonstrates that the two data sets are more reliable

Results - Combined



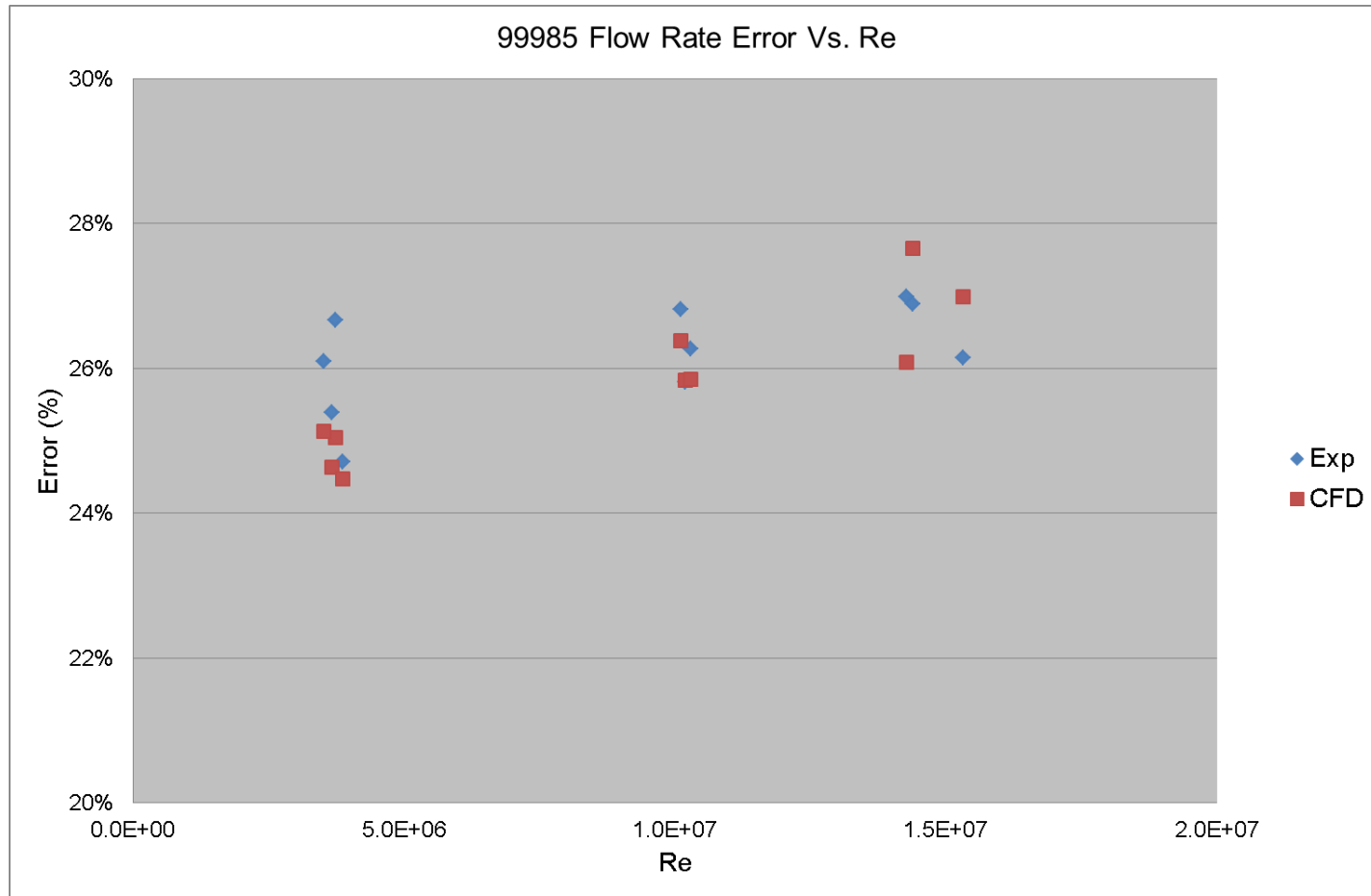
Results - Combined



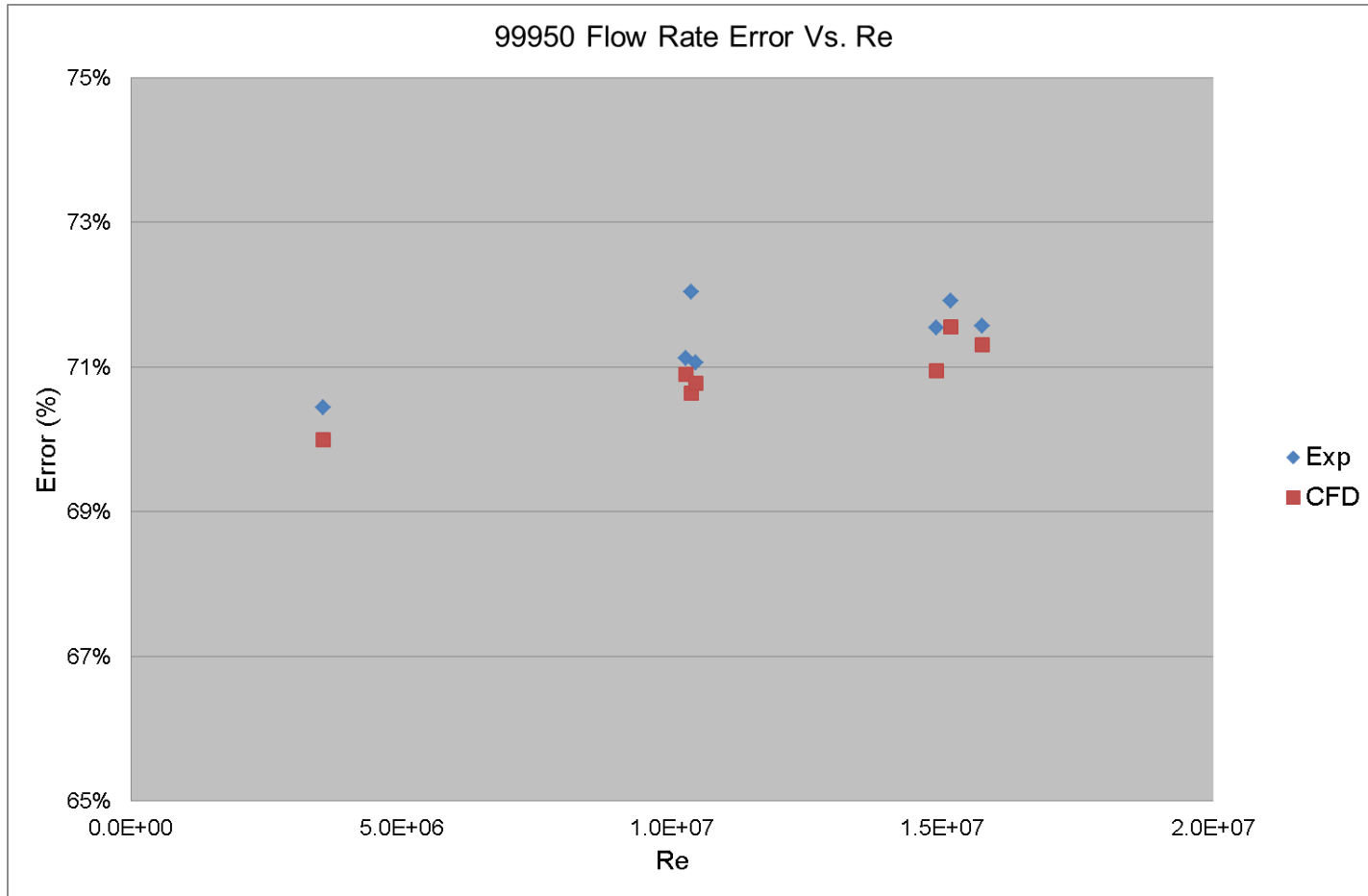
Correlation Significance

- Errors plotted against Reynolds Number
- Coefficients of determination for the 99985 and 99950 datasets are 0.536 and 0.549 respectively
- Correlation of each dataset is significant based on a two-sided T-test with 95% confidence interval
- Therefore errors should be determined based on flow rates (i.e. not a single correction factor)

Correlation Significance



Correlation Significance



Calculation of Flow Rate Bands

- 1, 3 and 4.5 Mscm/d flow rates used during testing
- Corrected to measured flow rates using corresponding error values
- Midpoint between flow rates used as cut-off point
- Error Period 1 (99985 counter reading)

	Test Flow (Mscm/d)	Error (%)	Measured Flow (Mscm/d)	Flow Range (Mscm/d)	# of Days	Correction Factor
Low	1	25.716	0.743	< 1.477	275	1.346188
Medium	3	26.305	2.211	1.477 to 2.755	96	1.356940
High	4.5	26.677	3.300	≥ 2.755	0	1.363833

- Error Period 2 (99950 counter reading)

	Test Flow (Mscm/d)	Error (%)	Measured Flow (Mscm/d)	Flow Range (Mscm/d)	# of Days	Correction Factor
Low	1	70.437	0.296	< 0.577	15	3.382663
Medium	3	71.405	0.858	0.577 to 1.066	0	3.497065
High	4.5	71.677	1.275	≥ 1.066	0	3.530691

Summary of First Error Period

- 21st July 2009 to 27th July 2010
- Counter reading of 99985 based on
 - ~31% step change in flow rate when the plate was inserted
 - 99885 values stamped on the carrier information plate
 - Pattern of contamination compared to physical measurements
- Error is dependent on flow rate
- Error in low flow rate band for 275 days
 - 25.716 % (under-registration)
- Error in medium flow rate band for 96 days
 - 26.305 % (under-registration)

Summary of Second Error Period

- 27th July 2010 to 10th August 2010
- Counter reading of 99950 based on
 - ~69% step change in flow rate when the plate location was corrected
 - 9995 value stamped on the carrier information plate
 - Interviews with mechanical operatives
- Error is dependent on flow rate
- Error in low flow rate band for 15 days
 - 70.437 % (under-registration)

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Thank you. Any Questions?

