ASSESSMENT OF ERROR DUE TO ORIFICE DIAMETER MIS-MEASUREMENT AT WHITWELL

A Report for

National Grid
Brick Kiln Street
HINCKLEY
Leicestershire
LE10 0NA

PROJECT NO: NGR010 **REPORT NO: 2010/183_Rev 1** **DATE: 17 JUNE 2010**

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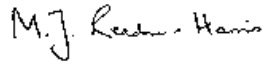
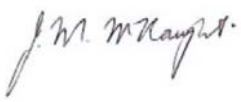
Prepared by:	Approved by:
	
Dr M J Reader-Harris	**J M McNaught**

for
Michael Valente
Managing Director

Date: 17June 2010

EXECUTIVE SUMMARY

Owing to a mis-measurement of orifice diameters flows have been mis-measured at affected offtakes connected to the National Transmission System. This project has been undertaken to resolve these errors.

At Whitwell correction factors should be applied as follows:

Meter tube	Date	Correction factor $q_{m,c}/q_{m,o}$
MTA	29/08/2007 to 01/10/2008	1.002429
MTB	29/08/2007 to 01/10/2008	1.002545

Over the period 29/08/2007 to 01/10/2008 inclusive the flow and corrected flow in the two tubes were as follows:

	MTA	MTB
Flow (mscm)	852.74598	1380.37623
Corrected flow (mscm)	854.80555	1383.88774

CONTENTS

1 INTRODUCTION

Owing to a mis-measurement of orifice diameters flows have been mis-measured at affected offtakes connected to the National Transmission System. This project has been undertaken to resolve these errors. This report covers the flows through Whitwell in the period of the error. The Joint Office Error Codes are EA007 and EA008 for meter tubes MTA and MTB.

2 ORIFICE DIAMETERS

The calibrations of the orifice plates in question gave the measured diameters shown in Table 1. The diameters at 20 °C have been calculated.

TABLE 1

ORIFICE DIAMETERS

					Values at 20 °C
Calibration Reference	Plate serial no	Declared certificate date	Orifice bore (mm)	Temperature	Orifice bore (mm)
OP5043	489-1	15/03/05	311.942	21	311.9370
OP5044	488-3	11/03/05	311.377	21	311.3720
OP60041	488-4	18/07/06	311.325	21	311.3200
OP60042	489-2	18/07/06	311.2745	21	311.2695
OP70044	488-3	13/04/07	311.0965	21	311.0915
OP70045	489-1	13/04/07	311.643	21	311.6380
OP80050	488-4	13/08/08	311.331	20	311.3310
OP80051	489-2	13/08/08	311.2785	20.5	311.2760
OP80081	489-1	17/11/08	311.9435	20.3	311.9420
OP80082	488-3*	17/11/08	311.3875	20.1	311.3870
OP90034	489-2	17/08/09	311.2805	20.4	311.2785
OP90035	488-4	17/08/09	311.334	20.6	311.3310

* Described as ‘388-3’ on the Certificate.

Figure 1 shows the data from Table 1 for the orifice bores at 20°C. This figure shows that there is a reduction in measured diameter followed by a recovery. The deduction from this graph is that the plates were mis-measured.

The calibration certificates for the orifice plates are given as Appendix A.

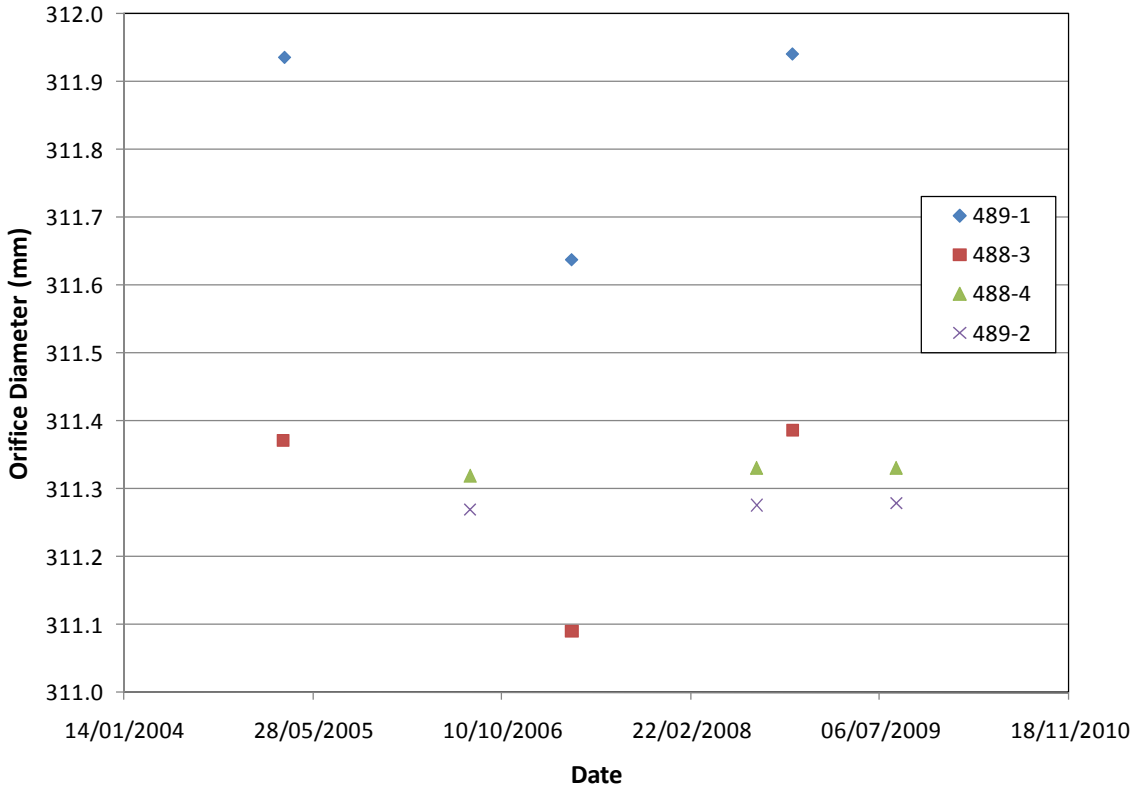


Figure 1 Orifice Diameters at 20 °C

The plates actually used in each of the two meter tubes are given in Table 2.

TABLE 2

PLATES USED IN EACH LINE AS CONFIGURED BY FLOW COMPUTER

Configuration data	omnL1013.cfg	omnM0829.cfg	omnN0605.cfg	omnN1001.cfg
MTA	13/10/2006 23:01	29/08/2007 23:01	05/06/2008 23:01	01/10/2008 23:01
Orifice plate bore diameter (mm)	311.325	311.0965	311.0965	311.2785
Expansion coefficient of the plate (/°C)	0.000016	0.000016	0.000016	0.000016
Orifice plate calibration temperature	21	21	21	20
Meter tube diameter (mm)	432.9	432.9	432.9	432.9
Expansion coefficient of the meter tube (/°C)	0.000011	0.000011	0.000011	0.000011
Meter tube calibration temperature	20	20	20	20
Isentropic Exponent	1.344	1.344	1.346217	1.346217
Dynamic Viscosity (Pa.s)	0.0000118	0.0000118	0.0000119	0.0000119
Orifice plate certificate number	OP60041	OP70044	OP70044	OP80051
Orifice plate serial number	488-4	488-3	488-3	489-2
Error in orifice diameter?	No	Yes	Yes	No
MTB				
Orifice plate bore diameter (mm)	311.2745	311.643	311.643	311.331
Expansion coefficient of the plate (/°C)	0.000016	0.000016	0.000016	0.000016
Orifice plate calibration temperature	21	21	21	20
Meter tube diameter (mm)	432.6467	432.6467	432.6467	432.6467
Expansion coefficient of the meter tube (/°C)	0.000011	0.000011	0.000011	0.000011
Meter tube calibration temperature	20	20	20	20
Isentropic Exponent	1.344	1.344	1.346217	1.346217
Dynamic Viscosity (Pa.s)	0.0000118	0.0000118	0.0000119	0.0000119
Orifice plate certificate number	OP60042	OP70045	OP70045	OP80050
Orifice plate serial number	489-2	489-1	489-1	488-4
Error in orifice diameter?	No	Yes	Yes	No

3 CORRECTING THE FLOWRATE

To correct the measured flowrate by replacing an incorrect diameter with the correct diameter might appear to be fairly straightforward. However, the data supplied only give time to the nearest minute and at four-minute intervals. This is inadequate for very accurate calculation. It is possible to calculate the flow over each time interval and to add the values over a day; this method can be used to check that the calculations are being done correctly, but the differences between the summed figures and the ones already given in the spreadsheet are too large to enable the correction to be calculated in this way. An alternative method has therefore been used.

The mass flowrate q_m is given by

$$q_m = \frac{\pi d^2 C \varepsilon \sqrt{2\rho\Delta p}}{4\sqrt{1-\beta^4}}$$

where d is the orifice diameter, C is the discharge coefficient, ε is the expansibility, ρ is the density, Δp is the differential pressure, and β is the diameter ratio.

If the corrected and original data are described with subscripts *c* and *o*, then the following correction factor is obtained:

$$\frac{q_{m,c}}{q_{m,o}} = \left(\frac{d_c}{d_o}\right)^2 \frac{C_c \varepsilon_c}{C_o \varepsilon_o} \sqrt{\frac{1-\beta_o^4}{1-\beta_c^4}}$$

The correct orifice diameter is taken as the average of the measurements shown in Table 1 for that plate excluding the erroneous measurement. It is then necessary to calculate C and ε in each case, and they were determined from the equations in ISO 5167-1:1991. C is a function of β and Re_D; so there is a change in C due to β, but the change varies with Reynolds number. Throughout the calculations the upstream pressure p_1 is taken as 57 bar a; the change in $q_{m,c}/q_{m,o}$ due to changing the static pressure by 10 bar is around 0.00005% at maximum.

Over the period from 29/08/2007 to 05/06/2008 the correction on MTA can be calculated as in Table 3. Throughout this calculation the meter tube diameter is 432.9 mm, the isentropic exponent is 1.344 and the dynamic viscosity is 0.0000118 Pa s.

TABLE 3

THE CORRECTION ON MTA FROM 29/08/2007 TO 05/06/2008

	d mm	β	ε	Re_D	C	$\frac{q_{m,c}}{q_{m,o}}$
Original: Δp=10 mbar	311.0915	0.718622	0.999934	4226862	0.600019	
Corrected Δp=10 mbar	311.3795	0.719287	0.999934	4237133	0.599960	1.0024299
Original Δp=500 mbar	311.0915	0.718622	0.996715	29775747	0.599688	
Corrected Δp=500 mbar	311.3795	0.719287	0.996713	29848022	0.599629	1.0024273

So $q_{m,c}/q_{m,o}$ is 1.002429.

Over the period from 29/08/2007 to 05/06/2008 the correction on MTB can be calculated as in Table 4. Throughout this calculation the meter tube diameter is 432.6467 mm, the isentropic exponent is 1.344 and the dynamic viscosity is 0.0000118 Pa s.

TABLE 4

THE CORRECTION ON MTB FROM 29/08/2007 TO 05/06/2008

	d mm	β	ε	Re_D	C	$\frac{q_{m,c}}{q_{m,o}}$
Original: Δp=10 mbar	311.638	0.720306	0.999934	4250426	0.599870	
Corrected Δp=10 mbar	311.9395	0.721003	0.999934	4261247	0.599807	1.0025459
Original Δp=500 mbar	311.638	0.720306	0.996709	29941544	0.599538	
Corrected Δp=500 mbar	311.9395	0.721003	0.996707	30017691	0.599475	1.0025432

So $q_{m,c}/q_{m,o}$ is 1.002545.

Over the period from 05/06/2008 to 01/10/2008 the correction on MTA can be calculated as in Table 5. Throughout this calculation the meter tube diameter is 432.9 mm, the isentropic exponent is 1.346217 and the dynamic viscosity is 0.0000119 Pa s.

TABLE 5

THE CORRECTION ON MTA FROM 05/06/2008 TO 01/10/2008

	d mm	β	ε	Re_D	C	$\frac{q_{m,c}}{q_{m,o}}$
Original: Δp=10 mbar	311.0915	0.718622	0.999934	4191362	0.600022	
Corrected Δp=10 mbar	311.3795	0.719287	0.999934	4201546	0.599963	1.0024299
Original Δp=500 mbar	311.0915	0.718622	0.996720	29525722	0.599689	
Corrected Δp=500 mbar	311.3795	0.719287	0.996718	29597390	0.599630	1.0024273

So $q_{m,c}/q_{m,o}$ is 1.002429.

Over the period from 05/06/2008 to 01/10/2008 the correction on MTB can be calculated as in Table 6. Throughout this calculation the meter tube diameter is 432.6467 mm, the isentropic exponent is 1.346217 and the dynamic viscosity is 0.0000119 Pa s.

TABLE 6

THE CORRECTION ON MTB FROM 05/06/2008 TO 01/10/2008

	d mm	β	ε	Re_D	C	$\frac{q_{m,C}}{q_{m,O}}$
Original: Δp=10 mbar	311.638	0.720306	0.999934	4214728	0.599873	
Corrected Δp=10 mbar	311.9395	0.721003	0.999934	4225458	0.599809	1.0025459
Original Δp=500 mbar	311.638	0.720306	0.996715	29690127	0.599539	
Corrected Δp=500 mbar	311.9395	0.721003	0.996712	29765635	0.599475	1.0025432

So $q_{m,c}/q_{m,o}$ is 1.002545.

4 CORRECTIONS ON A DAILY BASIS

Each (approximately four-minute) interval was considered and the flow (here and throughout this paragraph flow refers to standard volume flow) was calculated in each tube; the flowrate during the interval was taken as the average of that at the beginning and that at the end of the interval. The interval is only known to the nearest minute; so the flow in MTA during the interval was calculated by taking the product of the total flow (supplied by National Grid) during that interval and the ratio of the calculated flow in MTA to the sum of the calculated flows in the tubes. Intervals in which the calculated flow in both MTA and MTB is zero have been disregarded. Then on taking account of the effects at the beginning and end of each day the sum of the daily flow in MTA (obtained by summing the flows in each interval) and that in MTB (obtained the same way) should be equal to the total flow in that day. To ensure that the sum of the daily flows is exactly equal to the total daily flow the individual totals were scaled. Then the increase in daily flow was calculated for each of the two daily flows by using the percentage increase for each tube given above. Finally the total increase in the daily flow is the sum of the increases for the two tubes. The results are given in Table B.1 of Appendix B. The sum of the flows and the sum of the corrections have also been calculated by meter tube. It was assumed that on 29/08/2007 the orifice plates in MTA and MTB were changed between around 07:45 and 09:30 and that on 01/10/2008 the orifice plates in MTA and MTB were changed at 09:00 and 11:00 respectively.

5 CONCLUSIONS

Correction factors should be applied as shown in Table 7.

TABLE 7

CORRECTION FACTORS

Meter tube	Date	Correction factor $q_{m,c}/q_{m,o}$
MTA	29/08/2007 to 01/10/2008	1.002429
MTB	29/08/2007 to 01/10/2008	1.002545

These correction factors apply to both measured volume and measured energy.

On applying these corrections the corrected volumes are as shown in Appendix B.

Flows by meter tube are as shown in Table 8.

TABLE 8

FLOW IN THE PERIOD 29/08/2007 TO 01/10/2008 INCLUSIVE

	MTA	MTB
Flow (mscm)	852.74598	1380.37623
Correction (mscm)	2.05956	3.51151
Corrected flow (mscm)	854.80555	1383.88774
% change	0.2415	0.2544

APPENDIX A
ORIFICE PLATE CALIBRATION CERTIFICATES

TRANSCO ORIFICE PLATE CALIBRATION

DATE: ***15-03-05***

REF NO: ***OP5043***

TEMPERATURE: ***21 degsC***

MEASURED ORIFICE BORE: ***311.942mm***

PLATE DETAILS

PLATE SERIAL.	489-1	PLATE O.D	507.911mm		
MANUFACTURER:		PIPE I.D:	mm	SITE:	WHITWELL
MATERIAL CERT.No		DESIGN BORE	mm	FLOW:	10800000 M^3/day

TEST EQUIPMENT

MANUFACTURER & TYPE: KEMCO 700 MANUAL 3-DIMENSIONAL MEASURING MACHINE -ASSET NO OP-A02
CALIBRATED BY: QUALITY CONTROL TECHNOLOGY, CERT:- 4820 NEXT CAL DUE:- 15/10/05

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS:-	1	2			5	6	7	8
FLATNESS %	0.102	0.133	0.120	0.074	0.079	0.110	0.106	0.116
E' mm	9.058	9.069		9.069	9.062	9.091	9.070	9.062
'e' mm	7.008	7.013	7.024	7.007	7.007	7.011	7.017	7.011
EDGE SHARPNESS mm	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125
BEVEL ANGLE	45 DEGS							
CONCENTRICITY	0.042mm							
SURFACE FINISH (Ra)	0.7 microns							

DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS

ROUNDNESS : 0.007mm TAPER: 0 degs

COMMENTS:

INSPECTED BY ..... G.WARDLE

VERIFIED BY ..... P.KENNERSON

TRANSCO ORIFICE PLATE CALIBRATION

DATE: 11-03-05

REF NO: OP5044

TEMPERATURE: 21 degsC

MEASURED ORIFICE BORE: 311.377mm

PLATE DETAILS

PLATE SERIAL. 488-3 PLATE O.D 508.011mm

MANUFACTURER: PIPE I.D: mm SITE: WHITWELL

MATERIAL CERT.No. DESIGN BORE: mm FLOW: 10080000 M^3/day

TEST EQUIPMENT

MANUFACTURER & TYPE: KEMCO 700 MANUAL 3-DIMENSIONAL MEASURING MACHINE -ASSET NO OP-A02

CALIBRATED BY: QUALITY CONTROL TECHNOLOGY, CERT:- 4820 NEXT CAL DUE:- 15/10/05

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS:-	1	2	3	4	5			
FLATNESS %	0.009	0.003	0.001	0.039	0.008	0.001	0.008	0.001
'E' mm	9.547	9.511	9.521	9.532	9.537	9.540	9.545	9.565
'e' mm	7.243	7.217	7.251	7.283	7.314	7.297	7.272	
EDGE SHARPNESS mm	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125

BEVEL ANGLE: 44 DEGS

CONCENTRICITY 0.022mm

SURFACE FINISH (Ra) 1.7 microns

DOWNSTREAM FACE/EDGE VISUAL INSPECTION PASS

ROUNDNESS 0.013mm TAPER: 0 degs

COMMENTS:

INSPECTED BY G.WARDLE

VERIFIED BY. P.KENNERSON

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 18-07-06

REF NO: OP60041

TEMPERATURE: 21 degsC

MEASURED ORIFICE BORE: 311.325mm

PLATE DETAILS

PLATE SERIAL. 488-4
MANUFACTURER:
MATERIAL CERT.No. PSL506852

PLATE O.D 508.003mm
PIPE I.D: 433.197mm
DESIGN BORE: mm

SITE: WHITWELL
FLOW: 10.800000 M^3/DAY

TEST EQUIPMENT

MANUFACTURER & TYPE: KEMCO 700 MANUAL 3-DIMENSIONAL MEASURING MACHINE -ASSET NO OP-A02
CALIBRATED BY: QUALITY CONTROL TECHNOLOGY, CERT:- 4820 NEXT CAL DUE:- 14/10/06

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS:-	1	2	3	4	5	6		
FLATNESS mm	0.000	0.010	0.016	0.019	0.011	0.039	0.064	0.058
'E' mm	9.602	9.588	9.585	9.590	9.594	9.601	9.593	9.595
mm	6.789	6.714	6.623	6.578	6.645	6.679	6.746	6.803
EDGE SHARPNESS mm	0.0125	0.0125	SQUARE	0.0125	0.0125	0.0125	SQUARE	0.0125
BEVEL ANGLE:	44 DEGS							
CONCENTRICITY	0.219mm							
SURFACE FINISH (Ra)	2.4 microns							

DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS

ROUNDNESS 0.008mm TAPER: 0 degs

COMMENTS:

INSPECTED BY..... P.KENNERSON /J. CHAUHAN.

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 18-07-06

REF NO: OP60042

TEMPERATURE: 21 degsC

MEASURED ORIFICE BORE: 311.2745mm

PLATE DETAILS

PLATE SERIAL.	489-2	PLATE O.D	507.886mm		
MANUFACTURER:		PIPE I.D:	432.841mm	SITE:	WHITWELL
MATERIAL CERT.No.		DESIGN BORE:	mm	FLOW:	10.800000 M^3/DAY

TEST EQUIPMENT

MANUFACTURER & TYPE: KEMCO 700 MANUAL 3-DIMENSIONAL MEASURING MACHINE -ASSET NO OP-A02
CALIBRATED BY: QUALITY CONTROL TECHNOLOGY, CERT:- 4820 NEXT CAL DUE:- 14/10/06

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS:-	1	2		4	5	6	7	8
FLATNESS %	0.160	0.184	0.142	0.166	0.177	0.132	0.171	0.149
'E' mm	8.698	8.687	8.719	8.730	8.775	8.792	8.778	8.764
	6.489	6.488	6.595	6.796	6.919	6.916	6.808	6.665
EDGE SHARPNESS mm	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125

BEVEL ANGLE: 37 DEGS

CONCENTRICITY 0.233mm

SURFACE FINISH (Ra) 1.4 microns

DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS

ROUNDNESS : 0.014mm TAPER: 0 degs

COMMENTS

INSPECTED BY P.KENNERSON J.CHARLTON

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 13-04-07

REF NO: OP70044

TEMPERATURE: 21 degsC

MEASURED ORIFICE BORE: 311.0965mm

PLATE DETAILS

PLATE SERIAL.	488-3	PLATE O.D	507.581mm		
MANUFACTURER:		PIPE I.D:	mm	SITE:	WHITWELL
MATERIAL CERT.No.		DESIGN BORE:	mm	FLOW:	10080000 M^3/day

TEST EQUIPMENT

MANUFACTURER & TYPE: KEMCO 700 MANUAL 3-DIMENSIONAL MEASURING MACHINE -ASSET NO OP-A02
CALIBRATED BY: QUALITY CONTROL TECHNOLOGY, CERT:- 4820 NEXT CAL DUE:- 13/10/07

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS:	1	2	3	4	5			
FLATNESS %	0.020	0.019	0.031	0.026	0.030	0.027	0.008	0.017
'E' mm	9.578	9.502	9.510	9.589	9.596	9.524	9.528	9.590
'e' mm	7.257	7.217	7.248	7.316	7.352	7.278	7.250	
EDGE SHARPNESS mm	0.025	0.0125	0.0125	0.0125	0.0125	0.025	0.0125	0.0125

BEVEL ANGLE 44 DEGS

CONCENTRICITY 0.019mm

SURFACE FINISH (Ra) 3.4 microns

DOWNSTREAM FACE/EDGE VISUAL INSPECTION PASS

ROUNDNESS : 0.271mm TAPER: 0 degs

COMMENTS:

INSPECTED BY P.KENNERSON / J. CHAUHAN

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 13-04-07

REF NO: OP70045

TEMPERATURE: 21 degsC

MEASURED ORIFICE BORE: 311.643mm

PLATE DETAILS

PLATE SERIAL.	489-1	PLATE O.D	507.507mm		
MANUFACTURER:		PIPE I.D:	mm	SITE:	WHITWELL
MATERIAL CERT.No.		DESIGN BORE	mm	FLOW:	10800000 M^3/day

TEST EQUIPMENT

MANUFACTURER & TYPE: KEMCO 700 MANUAL 3 DIMENSIONAL MEASURING MACHINE -ASSET NO OP-A02

CALIBRATED BY: QUALITY CONTROL TECHNOLOGY, CERT:- 4820 NEXT CAL DUE:- 13/10/07

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS:-	1	2	3	4	5	6	7	8
FLATNESS %	0.105	0.145	0.113	0.091	0.107	0.112	0.115	0.113
'E' mm	9.097	9.043	9.069	9.120	9.104	9.067	9.060	9.104
'e' mm	7.059	6.991	7.004	7.037	7.036	6.994	7.006	7.043
EDGE SHARPNESS mm	0.0125	0.0125	0.0125	SQ	SQ	0.0125	SQ	SQ

BEVEL ANGLE: 45 DEGS

CONCENTRICITY 0.050mm

SURFACE FINISH (Ra) 0.5 microns

DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS

ROUNDNESS : 0.268mm TAPER: 0 degs

COMMENTS:

INSPECTED BY ..... P.KENNERSON / J. CHALLHAN

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 13-AUG-2008

REF NO: OP80050

TEMPERATURE: 20 degsC

MEASURED ORIFICE BORE: 311.331mm

PLATE DETAILS

PLATE SERIAL.	488-4	PLATE O.D	507.994mm		
MANUFACTURER:		PIPE I.D:	432.9mm	SITE:	WHITWELL
MATERIAL CERT.No.		DESIGN BORE	mm	FLOW:	10.800000 M^3/DAY

TEST EQUIPMENT

MANUFACTURER & TYPE: KEMCO 700 MANUAL 3-DIMENSIONAL MEASURING MACHINE -ASSET NO OP-A02
CALIBRATED BY: QUALITY CONTROL TECHNOLOGY, UKAS CERT:- 6292. NEXT CAL DUE:- 05-OCTOBER-2008

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS:-	1	2	3	4	5	6	7	8
FLATNESS %	0.013	0.003	0.022	0.007	0.010	0.023	0.054	0.062
'E' mm	9.593	9.589	9.587	9.593	9.593	9.593	9.591	9.586
e' mm	6.799	6.720	6.641	6.595	6.614	6.669	6.717	6.784
EDGE SHARPNESS mm	0.025	0.0125	0.0125	0.0125	0.0125	SQUARE	SQUARE	SQUARE

BEVEL ANGLE: 44 DEGS

CONCENTRICITY 0.212mm

SURFACE FINISH (Ra) 4.5 microns

DOWNSTREAM FACE/EDGE VISUAL INSPECTION PASS

ROUNDNESS 0.010mm TAPER 0 degs

DRAINHOLE PRESENT ? (YES/NO): No

COMMENTS: CLEAN PLATE.

INSPECTED BY: ..... M Livingstone.

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 13-AUG-2008

REF NO: OP80051

TEMPERATURE: 20.5 degsC

MEASURED ORIFICE BORE: 311.2785mm

PLATE DETAILS

PLATE SERIAL.	489-2	PLATE O.D	507.883mm		
MANUFACTURER:		PIPE I.D:	432.6467mm	SITE:	WHITWELL
MATERIAL CERT.No.		DESIGN BORE	mm	FLOW:	10.800000 M^3/DAY

TEST EQUIPMENT

MANUFACTURER & TYPE: KEMCO 700 MANUAL 3-DIMENSIONAL MEASURING MACHINE -ASSET NO OP-A02
CALIBRATED BY: QUALITY CONTROL TECHNOLOGY, UKAS CERT:- 6822. NEXT CAL DUE:- 03-OCTOBER-2009

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS:-	1	2	3	4	5			8
FLATNESS %	0.144	0.181	0.144	0.168	0.166	0.136	0.165	0.154
'E mm	8.688	8.683	8.708	8.724	8.712	8.718	8.726	8.717
mm	6.681	6.653	6.597	6.788	6.759	6.752	6.728	6.634
EDGE SHARPNESS mm	0.0125	0.0125	SQUARE	0.0125	0.0125	SQUARE	SQUARE	SQUARE

BEVEL ANGLE: 37 DEGS

CONCENTRICITY 0.221mm

SURFACE FINISH (Ra) 1.2 microns

DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS

ROUNDNESS 0.009mm TAPER 0 degs

DRAINHOLE PRESENT ? (YES/NO): No

COMMENTS: LIGHT PITTING U-STREAM AND D-STREAM

INSPECTED BY..... M Livingstone

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 17-NOV-2008

REF NO: OP80081

TEMPERATURE: 20.3 degsC

MEASURED ORIFICE BORE: 311.9435mm

PLATE DETAILS

PLATE SERIAL.	489-1	PLATE O.D	507.910mm		
MANUFACTURER:		PIPE I.D:	432.6467mm	SITE:	WHITWELL
MATERIAL CERT.No.		DESIGN BORE	mm	FLOW:	10800000 M^3/DAY

TEST EQUIPMENT

MANUFACTURER & TYPE: KEMCO 700 MANUAL 3-DIMENSIONAL MEASURING MACHINE -ASSET NO OP-A02
CALIBRATED BY: QUALITY CONTROL TECHNOLOGY, UKAS CERT:- 6822. NEXT CAL DUE:- 03-OCTOBER-2009

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS:-	1	2		4	5	6	7	8
FLATNESS %	0.105	0.109	0.101	0.090	0.103	0.092	0.131	0.108
E' mm	9.045	9.052	9.077	9.059	9,049	9.087	9.076	9.050
e' mm	7.002	7.006	7.028	6.996	6.992	7.020	7.006	7.007
EDGE SHARPNESS mm	0.0125	0.0125	0.0125	0.0125	SQUARE	SQUARE	0.0125	SQUARE
BEVEL ANGLE:	45 DEGS							
CONCENTRICITY	0.035mm							
SURFACE FINISH (Ra)	0.3 microns							

DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS

ROUNDNESS 0.012mm TAPER: 0 degs

DRAINHOLE PRESENT ? (YES/NO): No

COMMENTS: LIGHT BROWN DEPOSIT TO UPSTREAM

INSPECTED BY..... M Livingstone

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 17-NOV-2008

REF NO: OP80082

TEMPERATURE: 20.1 degsC

MEASURED ORIFICE BORE: 311.3875mm

PLATE DETAILS

PLATE SERIAL.	388-3	PLATE O.D	507.996mm		
MANUFACTURER:		PIPE I.D:	432.9mm	SITE:	WHITWELL
MATERIAL CERT.No		DESIGN BORE	mm	FLOW:	10080000 M^3/DAY

TEST EQUIPMENT

MANUFACTURER & TYPE: KEMCO 700 MANUAL 3-DIMENSIONAL MEASURING MACHINE -ASSET NO OP-A02
CALIBRATED BY: QUALITY CONTROL TECHNOLOGY, UKAS CERT:- 6822. NEXT CAL DUE:- 03-OCTOBER-2009

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS:-	1	2	3	4	5		7	8
FLATNESS %	0.019	0.008	0.003	0.030	0.020	0.013	0.010	0.003
'E' mm	9.519	9.511	9.526	9.525	9.528	9.543	9.545	9.534
mm	7.220	7.231	7.260	7.285	7.301	7.297	7.264	7.242
EDGE SHARPNESS mm	SQUARE	0.0125	SQUARE	0.025	0.025	0.0125	0.025	0.0125

BEVEL ANGLE: 44 DEGS

CONCENTRICITY 0.031mm

SURFACE FINISH (Ra) 0.8 microns

DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS

ROUNDNESS 0.012mm TAPER: 0 degs

DRAINHOLE PRESENT ? (YES/NO) No

COMMENTS: LIGHT GREASE TO UPSTREAM FACE

INSPECTED BY ..... M Livingstone

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 17-AUG-2009

REF NO: OP90034

TEMPERATURE: 20.4 degsC

MEASURED ORIFICE BORE: 311.2805mm

PLATE DETAILS

PLATE SERIAL.	489-2	PLATE O.D	507.882mm		
MANUFACTURER:		PIPE I.D:	432.6467mm	SITE:	WHITWELL
MATERIAL CERT.No		DESIGN BORE	mm	FLOW:	10.800000 M^3/DAY

TEST EQUIPMENT

MANUFACTURER & TYPE: KEMCO 700 MANUAL 3-DIMENSIONAL MEASURING MACHINE -ASSET NO OP-A02
CALIBRATED BY: QUALITY CONTROL TECHNOLOGY, UKAS CERT:- 6822. NEXT CAL DUE:- 03-OCTOBER-2009

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS:	1	2	3	4		6	7	8
FLATNESS %	0.159	0.185	0.157	0.184	0.181	0.148	0.186	0.171
	8.693	8.690	8.714	8.738	8.773	8.794	8.786	8.750
	6.489	6.454	6.560	6.773	6.952	6.965	6.833	6.643
EDGE SHARPNESS mm	SQUARE	0.0125	0.025	SQUARE	0.0125	0.0125	0.025	0.0125

BEVEL ANGLE: 37 DEGS

CONCENTRICITY 0.226mm

SURFACE FINISH (Ra) 1.2 microns

DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS

ROUNDNESS 0.016mm TAPER: 0 degs

DRAINHOLE PRESENT ? (YES/NO): No

COMMENTS: CLEAN PLATE

INSPECTED BY..... M Livingstone

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 17-AUG-2009

REF NO: OP90035

TEMPERATURE: 20.6 degsC

MEASURED ORIFICE BORE: 311.334mm

PLATE DETAILS

PLATE SERIAL.	488-4	PLATE O.D	507.992mm		
MANUFACTURER:		PIPE I.D:	439.9mm	SITE:	WHITWELL
MATERIAL CERT.No.		DESIGN BORE	mm	FLOW:	10.800000 M^3/DAY

TEST EQUIPMENT

MANUFACTURER & TYPE: KEMCO 700 MANUAL 3-DIMENSIONAL MEASURING MACHINE -ASSET NO OP-A02
CALIBRATED BY: QUALITY CONTROL TECHNOLOGY, UKAS CERT:- 6822. NEXT CAL DUE:- 03-OCTOBER-2009

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS:-	1	2		4	5	6	7	8
FLATNESS %	0.016	0.001	0.025	0.010	0.000	0.026	0.045	0.045
'E' mm	9.592	9.593	9.593	9.589	9.596	9.599	9.594	9.586
'e' mm	6.797	6.897	6.644	6.585	6.620	6.667	6.730	6.767
EDGE SHARPNESS mm	0.025	0.0125	0.025	0.025	0.025	0.0125	0.025	0.025

BEVEL ANGLE: 44 DEGS

CONCENTRICITY 0.206mm

SURFACE FINISH (Ra) 4.3 microns

DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS

ROUNDNESS 0.011mm TAPER: 0 degs

DRAINHOLE PRESENT ? (YES/NO): No

COMMENTS: GREASE TO UPSTREAM

INSPECTED BY..... M Livingstone.

APPENDIX B
CORRECTED DAILY VOLUME FLOWS

TABLE B.1

FLOWS AT WHITWELL DURING THE PERIOD OF THE MIS-MEASUREMENT

	Original Values (total)	Corrected values (total)	% increase
Date	Volume (mscm)	Volume (mscm)	Volume (mscm)
29/8/2007	1.25201	**1.25470**	0.2148
30/8/2007	0	**0.00000**	
31/8/2007	0	**0.00000**	
1/9/2007	2.85101	**2.85827**	0.2545
2/9/2007	3.09094	**3.09881**	0.2545
3/9/2007	3.77301	**3.78261**	0.2545
4/9/2007	3.96405	**3.97414**	0.2545
5/9/2007	3.31799	**3.32643**	0.2545
6/9/2007	3.198	**3.20614**	0.2545
7/9/2007	3.12201	**3.12996**	0.2545
8/9/2007	3.15094	**3.15896**	0.2545
9/9/2007	3.27301	**3.28134**	0.2545
10/9/2007	3.64404	**3.65331**	0.2545
11/9/2007	3.66901	**3.67835**	0.2545
12/9/2007	3.32796	**3.33641**	0.2540
13/9/2007	3.45099	**3.45977**	0.2545
14/9/2007	3.30804	**3.31646**	0.2545
15/9/2007	3.33698	**3.34547**	0.2545
16/9/2007	3.35004	**3.35857**	0.2545
17/9/2007	4.22198	**4.23272**	0.2545
18/9/2007	5.31299	**5.32651**	0.2545
19/9/2007	4.922	**4.93453**	0.2545
20/9/2007	4.09698	**4.10741**	0.2545
21/9/2007	3.71899	**3.72845**	0.2545
22/9/2007	3.45105	**3.45983**	0.2545
23/9/2007	3.61597	**3.62517**	0.2545
24/9/2007	4.10901	**4.11947**	0.2545
25/9/2007	5.30499	**5.31849**	0.2545
26/9/2007	6.95898	**6.97669**	0.2545
27/9/2007	7.41803	**7.43691**	0.2545
28/9/2007	7.15399	**7.17220**	0.2545
29/9/2007	5.35699	**5.37062**	0.2545
30/9/2007	6.495	**6.51153**	0.2545
1/10/2007	6.86304	**6.88051**	0.2545
2/10/2007	6.31195	**6.32801**	0.2545
3/10/2007	5.72003	**5.73459**	0.2545
4/10/2007	5.40399	**5.41774**	0.2545
5/10/2007	6.12301	**6.13859**	0.2545
6/10/2007	5.38	**5.39369**	0.2545
7/10/2007	6.08301	**6.09849**	0.2545
8/10/2007	6.16095	**6.17663**	0.2545
9/10/2007	7.48505	**7.50383**	0.2508
10/10/2007	3.94299	**3.95302**	0.2544
11/10/2007	5.04596	**5.05880**	0.2545
12/10/2007	4.07904	**4.08942**	0.2545
13/10/2007	4.92499	**4.93752**	0.2545

14/10/2007	5.23798	**5.25131**	0.2545
15/10/2007	6.03302	**6.04788**	0.2463
16/10/2007	6.33197	**6.34735**	0.2429
17/10/2007	6.81805	**6.83461**	0.2429
18/10/2007	4.90698	**4.91890**	0.2429
19/10/2007	6.914	**6.93079**	0.2429
20/10/2007	5.70099	**5.71484**	0.2429
21/10/2007	5.10803	**5.12044**	0.2429
22/10/2007	6.835	**6.85160**	0.2429
23/10/2007	7.868	**7.88749**	0.2477
24/10/2007	6.355	**6.37050**	0.2439
25/10/2007	5.346	**5.35899**	0.2429
26/10/2007	5.061	**5.07329**	0.2429
27/10/2007	3.976	**3.98566**	0.2429
28/10/2007	4.073	**4.08289**	0.2429
29/10/2007	6.813	**6.82955**	0.2429
30/10/2007	7.001	**7.01801**	0.2429
31/10/2007	6.39	**6.40552**	0.2429
1/11/2007	6.522	**6.53784**	0.2429
2/11/2007	4.907	**4.91892**	0.2429
3/11/2007	5.666	**5.67976**	0.2429
4/11/2007	6.889	**6.90573**	0.2429
5/11/2007	8.926	**8.94768**	0.2429
6/11/2007	8.438	**8.45850**	0.2429
7/11/2007	7.962	**7.98134**	0.2429
8/11/2007	7.822	**7.84100**	0.2429
9/11/2007	6.636	**6.65212**	0.2429
10/11/2007	6.20599	**6.22106**	0.2429
11/11/2007	6.873	**6.88969**	0.2429
12/11/2007	6.94501	**6.96188**	0.2429
13/11/2007	7.09399	**7.11122**	0.2429
14/11/2007	8.21701	**8.23697**	0.2429
15/11/2007	8.23099	**8.25098**	0.2429
16/11/2007	8.72501	**8.74620**	0.2429
17/11/2007	7.505	**7.52323**	0.2429
18/11/2007	7.813	**7.83198**	0.2429
19/11/2007	8.351	**8.37143**	0.2446
20/11/2007	7.09399	**7.11164**	0.2488
21/11/2007	6.46001	**6.47608**	0.2488
22/11/2007	6.69099	**6.70763**	0.2488
23/11/2007	8.228	**8.24847**	0.2488
24/11/2007	8.994	**9.01637**	0.2488
25/11/2007	6.56801	**6.58435**	0.2488
26/11/2007	7.25499	**7.27304**	0.2488
27/11/2007	6.58099	**6.59736**	0.2488
28/11/2007	6.233	**6.24851**	0.2488
29/11/2007	6.71402	**6.73072**	0.2487
30/11/2007	6.43399	**6.45000**	0.2488
1/12/2007	6.96201	**6.97933**	0.2488
2/12/2007	6.629	**6.64549**	0.2488
3/12/2007	7.39301	**7.41140**	0.2488
4/12/2007	6.703	**6.71967**	0.2488
5/12/2007	5.73798	**5.75240**	0.2513
6/12/2007	5.47	**5.48392**	0.2545
7/12/2007	6.19302	**6.20878**	0.2545
8/12/2007	7.89301	**7.91310**	0.2545
9/12/2007	7.55499	**7.57422**	0.2545

10/12/2007	8.64899	**8.67059**	0.2498
11/12/2007	9.259	**9.28203**	0.2488
12/12/2007	10.071	**10.09605**	0.2488
13/12/2007	9.56299	**9.58678**	0.2488
14/12/2007	9.12601	**9.14871**	0.2488
15/12/2007	8.888	**8.91011**	0.2488
16/12/2007	8.892	**8.91412**	0.2488
17/12/2007	10.623	**10.64942**	0.2487
18/12/2007	9.60703	**9.63093**	0.2488
19/12/2007	10.046	**10.07099**	0.2488
20/12/2007	10.49	**10.51610**	0.2488
21/12/2007	9.69702	**9.72114**	0.2488
22/12/2007	7.41898	**7.43744**	0.2488
23/12/2007	8.66202	**8.68357**	0.2488
24/12/2007	8.41599	**8.43693**	0.2488
25/12/2007	5.86002	**5.87460**	0.2488
26/12/2007	6.543	**6.55928**	0.2488
27/12/2007	7.02399	**7.04146**	0.2488
28/12/2007	6.81802	**6.83498**	0.2488
29/12/2007	7.04199	**7.05951**	0.2488
30/12/2007	6.659	**6.67557**	0.2488
31/12/2007	6.70203	**6.71870**	0.2488
1/1/2008	6.68799	**6.70463**	0.2488
2/1/2008	9.5629	**9.58669**	0.2488
3/1/2008	9.686	**9.71009**	0.2488
4/1/2008	9.669	**9.69305**	0.2488
5/1/2008	10.299	**10.32462**	0.2488
6/1/2008	10.711	**10.73764**	0.2488
7/1/2008	11.037	**11.06445**	0.2488
8/1/2008	9.34401	**9.36725**	0.2488
9/1/2008	8.259	**8.27954**	0.2488
10/1/2008	8.097	**8.11714**	0.2488
11/1/2008	8.278	**8.29859**	0.2488
12/1/2008	7.511	**7.52968**	0.2488
13/1/2008	6.826	**6.84298**	0.2488
14/1/2008	8.119	**8.13920**	0.2488
15/1/2008	7.779	**7.79835**	0.2488
16/1/2008	8.686	**8.70761**	0.2488
17/1/2008	9.35501	**9.37828**	0.2488
18/1/2008	7.57199	**7.59083**	0.2488
19/1/2008	4.513	**4.52423**	0.2488
20/1/2008	4.35201	**4.36284**	0.2488
21/1/2008	6.077	**6.09212**	0.2488
22/1/2008	8.043	**8.06301**	0.2488
23/1/2008	6.32701	**6.34275**	0.2488
24/1/2008	7.147	**7.16478**	0.2488
25/1/2008	8.56999	**8.59131**	0.2488
26/1/2008	7.655	**7.67404**	0.2488
27/1/2008	7.19101	**7.20890**	0.2488
28/1/2008	8.47899	**8.50008**	0.2488
29/1/2008	8.25101	**8.27154**	0.2488
30/1/2008	8.19	**8.21037**	0.2488
31/1/2008	9.842	**9.86648**	0.2488
1/2/2008	9.494	**9.51762**	0.2488
2/2/2008	9.21501	**9.23793**	0.2488
3/2/2008	8.44699	**8.46800**	0.2488
4/2/2008	7.80399	**7.82340**	0.2488

5/2/2008	6.60901	**6.62545**	0.2488
6/2/2008	7.384	**7.40237**	0.2488
7/2/2008	7.332	**7.35024**	0.2488
8/2/2008	6.427	**6.44299**	0.2488
9/2/2008	6.151	**6.16630**	0.2488
10/2/2008	6.76999	**6.78683**	0.2488
11/2/2008	7.746	**7.76527**	0.2488
12/2/2008	7.625	**7.64397**	0.2488
13/2/2008	8.35101	**8.37178**	0.2488
14/2/2008	8.79099	**8.81286**	0.2488
15/2/2008	9.31802	**9.34120**	0.2488
16/2/2008	10.648	**10.67449**	0.2488
17/2/2008	10.341	**10.36672**	0.2488
18/2/2008	9.81	**9.83440**	0.2488
19/2/2008	9.664	**9.68804**	0.2488
20/2/2008	8.98102	**9.00336**	0.2488
21/2/2008	7.603	**7.62191**	0.2488
22/2/2008	6.63901	**6.65553**	0.2488
23/2/2008	6.32898	**6.34472**	0.2488
24/2/2008	5.30402	**5.31721**	0.2488
25/2/2008	6.78	**6.79687**	0.2488
26/2/2008	6.04898	**6.06403**	0.2488
27/2/2008	6.85703	**6.87409**	0.2487
28/2/2008	7.48199	**7.50060**	0.2488
29/2/2008	7.09799	**7.11565**	0.2488
1/3/2008	6.35001	**6.36581**	0.2488
2/3/2008	5.664	**5.67809**	0.2488
3/3/2008	7.67599	**7.69509**	0.2488
4/3/2008	9.246	**9.26900**	0.2488
5/3/2008	8.17499	**8.19533**	0.2488
6/3/2008	6.914	**6.93120**	0.2488
7/3/2008	6.44299	**6.45902**	0.2488
8/3/2008	7.17999	**7.19785**	0.2488
9/3/2008	6.41205	**6.42800**	0.2488
10/3/2008	8.31396	**8.33464**	0.2488
11/3/2008	7.73602	**7.75526**	0.2488
12/3/2008	8.427	**8.44810**	0.2504
13/3/2008	7.31897	**7.33718**	0.2488
14/3/2008	5.547	**5.56086**	0.2498
15/3/2008	4.67303	**4.68492**	0.2545
16/3/2008	6.43597	**6.45235**	0.2545
17/3/2008	7.41803	**7.43691**	0.2545
18/3/2008	9.04498	**9.06753**	0.2493
19/3/2008	8.78302	**8.80487**	0.2488
20/3/2008	8.63501	**8.65649**	0.2488
21/3/2008	6.56299	**6.57932**	0.2488
22/3/2008	7.98297	**8.00283**	0.2487
23/3/2008	8.72504	**8.74674**	0.2488
24/3/2008	8.13495	**8.15519**	0.2488
25/3/2008	8.57501	**8.59634**	0.2488
26/3/2008	7.276	**7.29410**	0.2488
27/3/2008	5.82404	**5.83822**	0.2434
28/3/2008	7.36896	**7.38686**	0.2429
29/3/2008	6.42004	**6.43563**	0.2429
30/3/2008	4.42896	**4.43972**	0.2429
31/3/2008	4.54303	**4.55407**	0.2429
1/4/2008	4.52399	**4.53498**	0.2429

2/4/2008	4.31	**4.32047**	0.2429
3/4/2008	6.521	**6.53684**	0.2429
4/4/2008	6.42804	**6.44365**	0.2429
5/4/2008	7.48199	**7.50016**	0.2429
6/4/2008	9.16296	**9.18552**	0.2462
7/4/2008	9.95105	**9.97580**	0.2488
8/4/2008	9.10596	**9.12861**	0.2488
9/4/2008	7.83801	**7.85751**	0.2488
10/4/2008	7.92401	**7.94372**	0.2488
11/4/2008	7.94897	**7.96830**	0.2432
12/4/2008	7.388	**7.40595**	0.2429
13/4/2008	7.18402	**7.20147**	0.2429
14/4/2008	6.19098	**6.20602**	0.2429
15/4/2008	6.974	**6.99094**	0.2429
16/4/2008	7.86304	**7.88214**	0.2429
17/4/2008	8.82098	**8.84285**	0.2480
18/4/2008	8.82098	**8.84292**	0.2488
19/4/2008	8.76703	**8.78884**	0.2488
20/4/2008	7.30402	**7.32219**	0.2488
21/4/2008	6.91095	**6.92852**	0.2543
22/4/2008	5.70001	**5.71452**	0.2545
23/4/2008	5.65802	**5.67242**	0.2545
24/4/2008	6.23596	**6.25183**	0.2545
25/4/2008	5.289	**5.30246**	0.2545
26/4/2008	3.71204	**3.72149**	0.2545
27/4/2008	4.02802	**4.03827**	0.2545
28/4/2008	4.91498	**4.92749**	0.2545
29/4/2008	6.33002	**6.34613**	0.2545
30/4/2008	7.40295	**7.42172**	0.2536
1/5/2008	6.19104	**6.20660**	0.2513
2/5/2008	5.45898	**5.47287**	0.2545
3/5/2008	4.05603	**4.06635**	0.2545
4/5/2008	4.51398	**4.52547**	0.2545
5/5/2008	4.49298	**4.50441**	0.2545
6/5/2008	4.29102	**4.30194**	0.2545
7/5/2008	3.698	**3.70741**	0.2545
8/5/2008	3.55603	**3.56508**	0.2545
9/5/2008	3.25494	**3.26322**	0.2545
10/5/2008	3.125	**3.13295**	0.2545
11/5/2008	3.15802	**3.16606**	0.2545
12/5/2008	3.36499	**3.37355**	0.2545
13/5/2008	3.69202	**3.70142**	0.2545
14/5/2008	3.95001	**3.96006**	0.2545
15/5/2008	5.07501	**5.08793**	0.2545
16/5/2008	6.08099	**6.09647**	0.2545
17/5/2008	6.37799	**6.39422**	0.2545
18/5/2008	5.98102	**5.99624**	0.2545
19/5/2008	6.82098	**6.83834**	0.2545
20/5/2008	6.45801	**6.47445**	0.2545
21/5/2008	5.151	**5.16411**	0.2545
22/5/2008	4.46002	**4.47137**	0.2545
23/5/2008	4.154	**4.16457**	0.2545
24/5/2008	3.747	**3.75654**	0.2545
25/5/2008	5.443	**5.45685**	0.2545
26/5/2008	6.877	**6.89450**	0.2545
27/5/2008	5.281	**5.29444**	0.2545
28/5/2008	4.832	**4.84430**	0.2545

29/5/2008	4.657	**4.66885**	0.2545
30/5/2008	4.19	**4.20066**	0.2545
31/5/2008	3.553	**3.56204**	0.2545
1/6/2008	4.29	**4.30092**	0.2545
2/6/2008	4.255	**4.26583**	0.2545
3/6/2008	5.064	**5.07689**	0.2545
4/6/2008	4.252	**4.26282**	0.2545
5/6/2008	3.724	**3.73348**	0.2545
6/6/2008	4.082	**4.09239**	0.2545
7/6/2008	4.143	**4.15354**	0.2545
8/6/2008	3.30801	**3.31643**	0.2545
9/6/2008	3.031	**3.03871**	0.2545
10/6/2008	3.358	**3.36655**	0.2545
11/6/2008	3.472	**3.48084**	0.2545
12/6/2008	4.186	**4.19665**	0.2545
13/6/2008	4.203	**4.21370**	0.2545
14/6/2008	3.655	**3.66430**	0.2545
15/6/2008	3.751	**3.76055**	0.2545
16/6/2008	3.882	**3.89188**	0.2545
17/6/2008	3.643	**3.65227**	0.2545
18/6/2008	2.276	**2.28179**	0.2545
19/6/2008	1.032	**1.03463**	0.2545
20/6/2008	0.269	**0.26968**	0.2545
21/6/2008	0.176	**0.17645**	0.2545
22/6/2008	0.414	**0.41505**	0.2545
23/6/2008	2.923	**2.93044**	0.2545
24/6/2008	3.31001	**3.31843**	0.2545
25/6/2008	2.806	**2.81314**	0.2545
26/6/2008	2.872	**2.87931**	0.2545
27/6/2008	3.096	**3.10388**	0.2545
28/6/2008	2.83099	**2.83819**	0.2545
29/6/2008	3.024	**3.03170**	0.2545
30/6/2008	3.106	**3.11390**	0.2545
1/7/2008	2.86099	**2.86827**	0.2545
2/7/2008	2.966	**2.97355**	0.2545
3/7/2008	3.198	**3.20614**	0.2545
4/7/2008	3.015	**3.02267**	0.2545
5/7/2008	2.765	**2.77204**	0.2545
6/7/2008	3.164	**3.17205**	0.2545
7/7/2008	3.51601	**3.52496**	0.2545
8/7/2008	3.62801	**3.63724**	0.2545
9/7/2008	3.93399	**3.94400**	0.2545
10/7/2008	3.349	**3.35752**	0.2545
11/7/2008	3.35701	**3.36555**	0.2545
12/7/2008	3.399	**3.40765**	0.2545
13/7/2008	3.185	**3.19311**	0.2545
14/7/2008	3.017	**3.02468**	0.2545
15/7/2008	2.95599	**2.96351**	0.2545
16/7/2008	3.07001	**3.07782**	0.2545
17/7/2008	3.424	**3.43271**	0.2545
18/7/2008	3.27701	**3.28535**	0.2545
19/7/2008	2.98799	**2.99559**	0.2545
20/7/2008	3.955	**3.96507**	0.2545
21/7/2008	3.39301	**3.40165**	0.2545
22/7/2008	3.17	**3.17807**	0.2545
23/7/2008	2.84	**2.84723**	0.2545
24/7/2008	2.815	**2.82216**	0.2545

25/7/2008	2.62	**2.62667**	0.2545
26/7/2008	2.408	**2.41413**	0.2545
27/7/2008	2.379	**2.38505**	0.2545
28/7/2008	2.54601	**2.55249**	0.2545
29/7/2008	2.685	**2.69183**	0.2545
30/7/2008	2.59999	**2.60661**	0.2545
31/7/2008	2.57901	**2.58557**	0.2545
1/8/2008	2.592	**2.59860**	0.2545
2/8/2008	2.355	**2.36099**	0.2545
3/8/2008	2.765	**2.77204**	0.2545
4/8/2008	2.90701	**2.91441**	0.2545
5/8/2008	3.006	**3.01365**	0.2545
6/8/2008	2.80099	**2.80812**	0.2545
7/8/2008	2.672	**2.67880**	0.2545
8/8/2008	2.918	**2.92543**	0.2545
9/8/2008	2.92902	**2.93647**	0.2545
10/8/2008	2.75998	**2.76700**	0.2545
11/8/2008	2.927	**2.93445**	0.2545
12/8/2008	3.17102	**3.17909**	0.2545
13/8/2008	3.32098	**3.32943**	0.2545
14/8/2008	3.32101	**3.32946**	0.2545
15/8/2008	3.14301	**3.15101**	0.2545
16/8/2008	2.82199	**2.82917**	0.2545
17/8/2008	2.94598	**2.95348**	0.2545
18/8/2008	2.67502	**2.68183**	0.2545
19/8/2008	3.742	**3.75152**	0.2545
20/8/2008	3.16599	**3.17405**	0.2545
21/8/2008	2.987	**2.99460**	0.2545
22/8/2008	3.061	**3.06879**	0.2545
23/8/2008	2.992	**2.99961**	0.2545
24/8/2008	1.29599	**1.29929**	0.2545
25/8/2008	2.39902	**2.40513**	0.2545
26/8/2008	2.92599	**2.93344**	0.2545
27/8/2008	3.11398	**3.12191**	0.2545
28/8/2008	2.85602	**2.86329**	0.2545
29/8/2008	2.79099	**2.79809**	0.2545
30/8/2008	2.552	**2.55849**	0.2545
31/8/2008	2.841	**2.84823**	0.2545
1/9/2008	3.14801	**3.15602**	0.2545
2/9/2008	3.38998	**3.39861**	0.2545
3/9/2008	3.71002	**3.71946**	0.2545
4/9/2008	2.79719	**2.80431**	0.2545
5/9/2008	3.13991	**3.14790**	0.2545
6/9/2008	3.668	**3.67734**	0.2545
7/9/2008	3.78098	**3.79060**	0.2545
8/9/2008	3.72803	**3.73752**	0.2545
9/9/2008	3.92899	**3.93899**	0.2545
10/9/2008	3.62399	**3.63321**	0.2545
11/9/2008	3.53799	**3.54699**	0.2545
12/9/2008	3.87003	**3.87988**	0.2545
13/9/2008	3.582	**3.59112**	0.2545
14/9/2008	3.82999	**3.83974**	0.2545
15/9/2008	4.05499	**4.06531**	0.2545
16/9/2008	4.77502	**4.78717**	0.2545
17/9/2008	4.23199	**4.24276**	0.2545
18/9/2008	4.712	**4.72399**	0.2545
19/9/2008	4.29498	**4.30591**	0.2545

20/9/2008	3.991	**4.00116**	0.2545
21/9/2008	4.035	**4.04527**	0.2545
22/9/2008	4.58301	**4.59467**	0.2545
23/9/2008	5.20999	**5.22325**	0.2545
24/9/2008	5.03	**5.04280**	0.2545
25/9/2008	4.54102	**4.55258**	0.2545
26/9/2008	4.521	**4.53251**	0.2545
27/9/2008	4.371	**4.38212**	0.2545
28/9/2008	4.59299	**4.60468**	0.2545
29/9/2008	5.04901	**5.06186**	0.2545
30/9/2008	5.83499	**5.84984**	0.2545
1/10/2008	6.19699	**6.19936**	0.0383