ASSESSMENT OF ERROR DUE TO ORIFICE DIAMETER MIS-MEASUREMENT AT ALREWAS WM

A Report for

National Grid
Brick Kiln Street
HINCKLEY
Leicestershire
LE10 0NA

PROJECT NO: NGR010 **REPORT NO: 2010/248** **DATE: 17 JUNE 2010**

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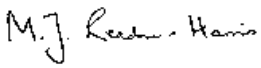
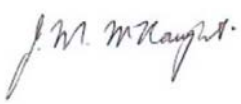
Prepared by:	Approved by:
	
Dr M J Reader-Harris	**J M McNaught**

for
Michael Valente
Managing Director

Date: 17 June 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 Alrewas WM a correction factor should be applied to MTB only as follows:

Meter tube	Date	Correction factor $q_{m,c}/q_{m,o}$
MTB	12/05/2008 to 05/05/2009	1.002331

Over the period 12/05/2008 to 05/05/2009 inclusive the flow and corrected flow in the two tubes were as follows:

	MTA	MTB
Flow (mscm)	291.50097	305.02253
Corrected flow (mscm)	291.50097	305.73337

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 Alrewas WM in the period of the error. The Joint Office Error Codes are WM001 and WM002 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)
OP4148	361-2	15/03/2005	541.777	21	541.7683
OP4151	355-5	26/04/2005	289.5755	21	289.5709
OP4152	360-4	26/04/2005	289.44	21	289.4354
OP50088	355-7	22/05/2006	289.583	21	289.5784
OP50090	360-5	22/05/2006	289.4225	21	289.4179
OP60115	355-5	04/04/2007	289.5745	21	289.5699
OP60116	360-4	04/04/2007	289.4375	20	289.4375
OP70059	355-7	13/06/2007	289.3125	21	289.3079
OP70060	360-5	09/05/2008	289.433	20	289.4330
OP80063	ALRE5036	01/10/2008	310.0185	19	310.0235
OP80064	360-4	01/10/2008	289.4435	20	289.4435
OP80065	355-5	01/10/2008	289.5805	20	289.5805
OP90047	355-7	06/11/2009	289.589	20.5	289.5867
OP90048	360-5	06/11/2009	289.4255	20.4	289.4236

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 a plate was mis-measured.

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

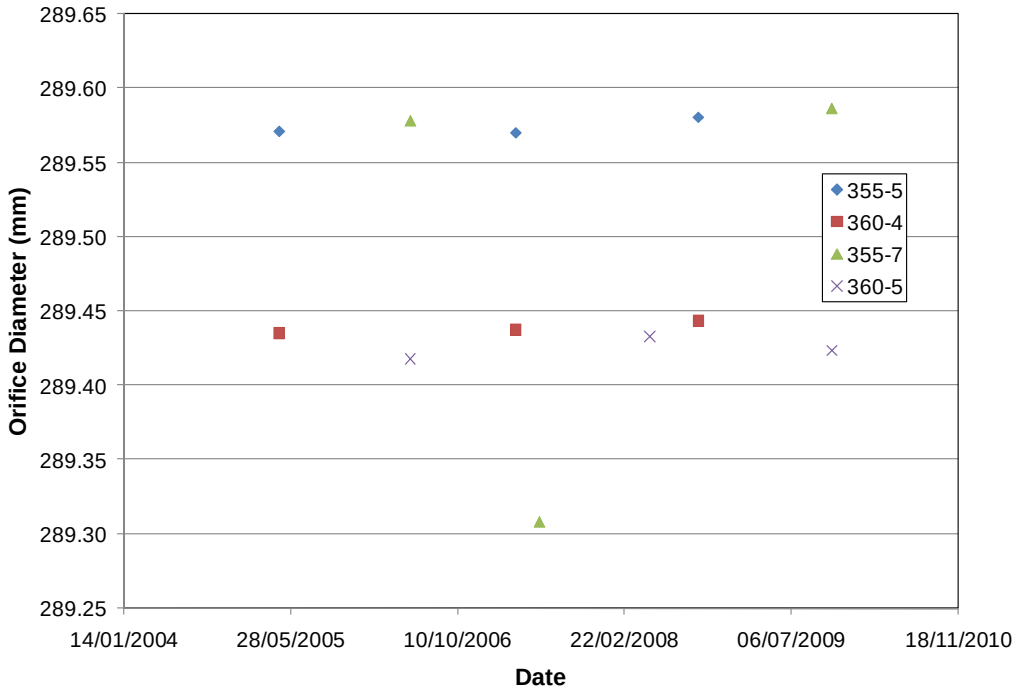


Figure 1 Orifice Diameters at 20 °C

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

TABLE 2

PLATES USED IN EACH LINE AS CONFIGURED BY FLOW COMPUTER – PART 1

Configuration data	omnN0212.cfg	omnN0512.cfg	omnN0513.cfg	omnN0515.cfg
MTA	13/02/2008 00:01	12/05/2008 23:01	13/05/2008 23:01	15/05/2008 23:01
Orifice plate bore diameter (mm)	289.4375	289.4375	289.4375	289.433
Expansion coefficient of the plate (/°C)	0.000016	0.000016	0.000016	0.000016
Orifice plate calibration temperature	20	20	20	20
Meter tube diameter (mm)	432.0604	432.0604	432.0604	432.0604
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	1.3404	1.347	1.3459	1.3459
Dynamic Viscosity (Pa.s)	0.0000121	0.0000121	0.0000121	0.0000121
Orifice plate certificate number	OP60116	OP60116	OP60116	OP70060
Orifice plate serial number	360-4	360-4	360-4	360-5
Error in orifice diameter?	No	No	No	No
MTB				
Orifice plate bore diameter (mm)	289.5745	289.3125	289.3125	289.3125
Expansion coefficient of the plate (/°C)	0.000016	0.000016	0.000016	0.000016
Orifice plate calibration temperature	21	21	21	21
Meter tube diameter (mm)	433.4415	433.4415	433.4415	433.4415
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	1.3404	1.3404	1.347	1.347
Dynamic Viscosity (Pa.s)	0.0000121	0.0000121	0.0000121	0.0000121
Orifice plate certificate number	OP60115	OP70059	OP70059	OP70059
Orifice plate serial number	355-5	355-7	355-7	355-7
Error in orifice diameter?	No	Yes	Yes	Yes

TABLE 2

PLATES USED IN EACH LINE AS CONFIGURED BY FLOW COMPUTER – PART 2

Configuration data	omnO0505.cfg	omnO0506.cfg	omnO0513.cfg
MTA	05/05/2009 23:01	06/05/2009 23:01	13/05/2009 23:01
Orifice plate bore diameter (mm)	289.4435	289.4435	289.4435
Expansion coefficient of the plate (/°C)	0.000016	0.000016	0.000016
Orifice plate calibration temperature	20	20	20
Meter tube diameter (mm)	432.0604	432.0604	432.0604
Expansion coefficient of the meter tube (/°C)	0.000011	0.000011	0.000011
Meter tube calibration temperature	20	20	20
Isentropic Exponent	1.3459	1.3459	1.341927
Dynamic Viscosity (Pa.s)	0.0000121	0.0000121	0.0000119
Orifice plate certificate number	OP70060	OP80064	OP80064
Orifice plate serial number	360-5	360-4	360-4
Error in orifice diameter?	No	No	No
MTB			
Orifice plate bore diameter (mm)	289.5805	289.5805	289.5805
Expansion coefficient of the plate (/°C)	0.000016	0.000016	0.000016
Orifice plate calibration temperature	20	20	20
Meter tube diameter (mm)	433.4415	433.4415	433.4415
Expansion coefficient of the meter tube (/°C)	0.000011	0.000011	0.000011
Meter tube calibration temperature	20	20	20
Isentropic Exponent	1.347	1.347	1.340945
Dynamic Viscosity (Pa.s)	0.0000121	0.0000121	0.0000119
Orifice plate certificate number	OP80065	OP80065	OP80065
Orifice plate serial number	355-5	355-5	355-5
Error in orifice diameter?	No	No	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 59 bar a; the change in $q_{m,c}/q_{m,o}$ due to changing the static pressure by 10 bar is around 0.00003% at maximum.

Over the period from 12/05/2008 to 13/05/2008 the correction on MTB can be calculated as in Table 3. Throughout this calculation the meter tube diameter is 433.4415 mm and the isentropic exponent is 1.3404 and the dynamic viscosity is 0.0000121 Pa s.

TABLE 3

THE CORRECTION ON MTB FROM 12/05/2008 TO 13/05/2008

	d mm	β	ε	Re_D	C	$\frac{q_{m,c}}{q_{m,o}}$
Original: Δp=10 mbar	289.3079	0.667467	0.999939	3519897	0.603130	
Corrected Δp=10 mbar	289.5825	0.668101	0.999939	3528106	0.603106	1.0023320
Original Δp=500 mbar	289.3079	0.667467	0.996969	24802486	0.602814	
Corrected Δp=500 mbar	289.5825	0.668101	0.996967	24860278	0.602790	1.0023301

So $q_{m,c}/q_{m,o}$ is 1.002331.

Over the period from 13/05/2008 to 05/05/2009 the correction on MTB can be calculated as in Table 4. Throughout this calculation the meter tube diameter is 433.4415 mm and the isentropic exponent is 1.347 and the dynamic viscosity is 0.0000121 Pa s.

TABLE 4

THE CORRECTION ON MTB FROM 13/05/2008 TO 05/05/2009

	d mm	β	ε	Re_D	C	$\frac{q_{m,c}}{q_{m,o}}$
Original: Δp=10 mbar	289.3079	0.667467	0.999940	3519898	0.603130	
Corrected Δp=10 mbar	289.5825	0.668101	0.999940	3528107	0.603106	1.0023320
Original Δp=500 mbar	289.3079	0.667467	0.996983	24802856	0.602814	
Corrected Δp=500 mbar	289.5825	0.668101	0.996982	24860648	0.602790	1.0023301

So $q_{m,c}/q_{m,o}$ is 1.002331.

4 CORRECTIONS ON A DAILY BASIS

Each (approximately twenty-three-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 orifice plates were changed at 11:00.

5 CONCLUSIONS

Correction factors should be applied as shown in Table 5. No correction factor is required for MTA.

TABLE 5

CORRECTION FACTORS

Meter tube	Date	Correction factor $q_{m,c}/q_{m,o}$
MTB	12/05/2008 to 05/05/2009	1.002331

This correction factor applies to both measured volume and measured energy.

On applying this correction the corrected volumes are as shown in Appendix B.

Flows by meter tube are as shown in Table 6.

TABLE 6

FLOW IN THE PERIOD 12/05/2008 TO 05/05/2009 INCLUSIVE

	MTA	MTB
Flow (mscm)	291.50097	305.02253
Correction (mscm)	0	0.71084
Corrected flow (mscm)	291.50097	305.73337
% change	0	0.2330

APPENDIX A
ORIFICE PLATE CALIBRATION CERTIFICATES

TRANSCO ORIFICE PLATE CALIBRATION

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

REF NO: ***OP4148***

TEMPERATURE: ***21 degsC***

MEASURED ORIFICE BORE: ***541.777mm***

PLATE DETAILS

PLATE SERIAL.	361-2	PLATE O.D	782.059mm		
MANUFACTURER:	DANIEL	PIPE I.D:	mm	SITE	ALREWAS
MATERIAL CERT.No	65234	DESIGN BORE	mm	FLOW	

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		2	3	4	5	6		8
FLATNESS %	0.270	0.106	0.153	0.419	0.282	0.058	0.157	0.267
'E mm	12.473	12.603	12.586	12.646	12.585	12.619	12.649	12.592
		9.558	9.557	9.556	9.563	9.684	9.589	9.518
EDGE SHARPNESS mm	0.0250	0.0250	0.0250	0.0250	0.0250	0.0250	0.0250	0.0250

BEVEL ANGLE 42 DEGS

CONCENTRICITY 0.171mm

SURFACE FINISH (Ra) 2.0 microns

DOWNSTREAM FACE/EDGE VISUAL INSPECTION PASS

ROUNDNESS 0.026mm TAPER 0 degs

COMMENTS

INSPECTED BY G.WARDLE

VERIFIED BY P.KENNERSON

TRANSCO ORIFICE PLATE CALIBRATION

DATE: 26-04-05

REF NO: OP4151

TEMPERATURE: 21 degsC

MEASURED ORIFICE BORE: 289.5755mm

PLATE DETAILS

PLATE SERIAL.	355-5	PLATE O.D	471.556mm		
MANUFACTURER:	DANIEL	PIPE I.D:	433.374mm	SITE:	ALREWAS
MATERIAL CERT.No		DESIGN BORE:	289.56mm	FLOW:	9174658 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	6	7	8
FLATNESS mm	0.056	0.053	0.092	0.276	0.175	0.070	0.018	0.027
mm	6.553	6.574	6.560	6.560	6.531	6.432	6.514	6.482
EDGE SHARPNESS mm	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125

BEVEL ANGLE DEGS

CONCENTRICITY 0.482mm

SURFACE FINISH (Ra)

DOWNSTREAM FACE/EDGE VISUAL INSPECTION PASS

ROUNDNESS 0.031mm TAPER 0 degs

COMMENTS

INSPECTED BY G.WARDLE

VERIFIED BY.. P.KENNERSON

TRANSCO ORIFICE PLATE CALIBRATION

DATE: 26-04-05

REF NO: OP4152

TEMPERATURE: 21 degsC

MEASURED ORIFICE BORE: 289.44mm

PLATE DETAILS

PLATE SERIAL.	360-4	PLATE O.D	455.494mm		
MANUFACTURER:		PIPE I.D:	432.130mm	SITE	ALREWAS
MATERIAL CERT.No		DESIGN BORE	289.407mm	FLOW	9174658 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		4				
FLATNESS %	0.365	0.106	0.006	0.155	0.271	0.049	0.060	0.348
'E' mm	6.599	6.561	6.593	6.616	6.628	6.564	6.584	6.592
'e'								
EDGE SHARPNESS mm	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125
BEVEL ANGLE								

CONCENTRICITY 0.051mm

SURFACE FINISH (Ra) 3.0 microns

DOWNSTREAM FACE/EDGE VISUAL INSPECTION PASS

ROUNDNESS 0.024mm TAPER 0 degs

COMMENTS

INSPECTED BY G.WARDLE

VERIFIED BY P.KENNERSON

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 22-05-06

REF NO: OP50088

TEMPERATURE: 21 degsC

MEASURED ORIFICE BORE: 289.583mm

PLATE DETAILS

PLATE SERIAL.	355-7	PLATE O.D	471.940mm		
MANUFACTURER:	DANIEL	PIPE I.D:	433.374mm	SITE:	ALREWAS
MATERIAL CERT.No	K69529	DESIGN BORE:	289.56mm	FLOW:	

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	7	8
FLATNESS %	0.054	0.022	0.060	0.095	0.017	0.001	0.036	0.075
E' mm	9.619	9.639	9.640	9.643	9.648	9.647	9.622	9.603
e' mm	7.082	7.141	7.237	7.201	7.179	7.171	7.179	7.233
EDGE SHARPNESS mm	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125

BEVEL ANGLE: 36 DEGS

CONCENTRICITY 0.332mm

SURFACE FINISH (Ra) 0.5 microns

DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS

ROUNDNESS : 0.016mm TAPER 0 degs

COMMENTS

INSPECTED BY. P.KENNERSON J. CHAMBERS

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 22-05-06

REF NO: OP50090

TEMPERATURE: 21 degsC

MEASURED ORIFICE BORE: 289.4225mm

PLATE DETAILS

PLATE SERIAL.	360-5	PLATE O.D	455.545mm		
MANUFACTURER:		PIPE I.D:	432.130mm	SITE	ALREWAS
MATERIAL CERT.No	373901	DESIGN BORE:	289.407mm	FLOW	

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		8
FLATNESS %	0.034	0.088	0.216	0.281	0.049	0.156	0.201	0.209
E mm	6.634	6.630	6.618	6.623	6.621	6.629	6.637	6.627
mm								
EDGE SHARPNESS mm	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125

BEVEL ANGLE: DEGS

CONCENTRICITY 0.117mm

SURFACE FINISH (Ra 1.4 micron

DOWNSTREAM FACE/EDGE VISUAL INSPECTION PASS

ROUNDNESS 0.024mm TAPER 0 degs

COMMENTS

INSPECTED BY P.KENNERSON J. CHAMBERS

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 04-04-07

REF NO: OP60115

TEMPERATURE: 21 degsC

MEASURED ORIFICE BORE: 289.5745mm

PLATE DETAILS

PLATE SERIAL.	355-5	PLATE O.D	471.465mm		
MANUFACTURER:	DANIEL	PIPE I.D:	433.374mm	SITE	ALREWAS
MATERIAL CERT.No		DESIGN BORE:	289.56mm	FLOW	

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		6	7	8
FLATNESS %	0.092	0.018	0.164	0.211	0.035	0.061	0.073	0.120
E mm	6.579	6.500	6.498	6.493	6.511	6.576	6.550	6.567
EDGE SHARPNESS mm	SQUARE	0.0125	0.0125	SQUARE	0.0125	0.0125	0.0125	0.0125

BEVEL ANGLE DEGS

CONCENTRICITY

SURFACE FINISH (Ra) 0.6 microns

DOWNSTREAM FACE/EDGE VISUAL INSPECTION PASS

ROUNDNESS 0.021mm TAPER: 0 degs

COMMENTS

INSPECTED BY P.KENNERSON

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 04-04-07

REF NO: OP60116

TEMPERATURE: 20 degsC

MEASURED ORIFICE BORE: 289.4375mm

PLATE DETAILS

PLATE SERIAL.	360-4	PLATE O.D	455.509mm		
MANUFACTURER:		PIPE I.D:	432.130mm	SITE	ALREWAS
MATERIAL CERT.No		DESIGN BORE	289.407mm	FLOW	

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			3	4	5	6		8
FLATNESS %	0.160		0.043	0.263	0.113	0.059	0.253	0.395
	6.617	6.586	6.564	6.596	6.622	6.620	6.591	6.575
mm								
EDGE SHARPNESS mm	0.0125	0.0125	SQUARE	SQUARE	0.0125	SQUARE	0.0125	0.0125

BEVEL ANGLE DEGS

CONCENTRICITY 0.043mm

SURFACE FINISH (Ra 0.9 microns

DOWNSTREAM FACE/EDGE VISUAL INSPECTION PASS

ROUNDNESS 0.016mm TAPER 0 degs

COMMENTS

INSPECTED BY P.KENNERSON

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 13-06-07

REF NO: OP70059

TEMPERATURE: 21 degsC

MEASURED ORIFICE BORE: 289.3125mm

PLATE DETAILS

PLATE SERIAL.	355-7	PLATE O.D	471.495mm		
MANUFACTURER:	DANIEL	PIPE I.D:	mm	SITE:	ALREWAS
MATERIAL CERT.No.		DESIGN BORE:	mm	FLOW:	

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		7	
FLATNESS %	0.051	0.016	0.067	0.065	0.065	0.046	0.043	0.031
'E' mm	9.668	9.612	9.625	9.698	9.701	9.632	9.602	9.653
'e' mm	7.168	7.113	7.210	7.263	7.219	7.146	7.177	
EDGE SHARPNESS mm	0.0125	0.0125	0.0125	0.0125	0.025	0.0125	0.0125	0.0125

BEVEL ANGLE: 36 DEGS

CONCENTRICITY 0.341mm

SURFACE FINISH (Ra) 0.4 microns

DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS

ROUNDNESS 0.262mm TAPER: 0 degs

COMMENTS:

INSPECTED BY..... ~~R KENNEDY~~ J. CHAUHAN

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 09-MAY-2008

REF NO: OP70060

TEMPERATURE: 20 degsC

MEASURED ORIFICE BORE: 289.433mm

PLATE DETAILS

PLATE SERIAL.	360-5	PLATE O.D	455.549mm		
MANUFACTURER:		PIPE I.D:	433.4415mm	SITE	ALREWAS
MATERIAL CERT.No		DESIGN BORE	mm	FLOW	M^3/DAY

TEST EQUIPMENT

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

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS	1	2	3	4	5			
FLATNESS %	0.119	0.033	0.208	0.067	0.170	0.207	0.196	0.052
'E mm	6.626	6.632	6.643	6.628	6.617	6.622	6.631	6.609
'e								
EDGE SHARPNESS mm	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.025	0.0125
BEVEL ANGLE								
CONCENTRICITY	0.134mm							
SURFACE FINISH (Ra)	0.6 microns							

DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS

ROUNDNESS : 0.025mm TAPER 0 degs

COMMENTS: CLEAN PLATE.

INSPECTED BY..... M Livingstone

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 01-OCT-2008

REF NO: OP80063

TEMPERATURE: 19 degsC

MEASURED ORIFICE BORE: 310.0185mm

PLATE DETAILS

PLATE SERIAL.	ALRE 5036	PLATE O.D	507.985mm		
MANUFACTURER:		PIPE I.D:	432.2096mm	SITE:	ALREWAS
MATERIAL CERT.No		DESIGN BORE:	mm	FLOW:	16X10E06 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 %	0.022	0.005	0.028	0.013	0.034	0.033	0.014	0.038
'E' mm	9.370	9.355	9.328	9.336	9.354	9.322	9.364	9.329
'e' mm	7.436	7.440	7.424	7.409	7.369	7.367	7.397	7.421
EDGE SHARPNESS mm	SQUARE	SQUARE	SQUARE	0.0125	SQUARE	0.0125	0.0125	SQUARE

BEVEL ANGLE: 44 DEGS

CONCENTRICITY 0.089mm

SURFACE FINISH (Ra) 0.8 microns

DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS

ROUNDNESS 0.009mm TAPER 0 degs

DRAINHOLE PRESENT ? (YES/NO): No

COMMENTS: CLEAN PLATE.

INSPECTED BY..... M Livingstone

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 01-OCT-2008

REF NO: OP80064

TEMPERATURE: 20 degsC

MEASURED ORIFICE BORE: 289.4435mm

PLATE DETAILS

PLATE SERIAL.	360-4	PLATE O.D	455.507mm		
MANUFACTURER:		PIPE I.D:	433.4415mm	SITE:	ALREWAS
MATERIAL CERT.No.		DESIGN BORE:	289.407mm	FLOW:	M^3/DA

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 %	0.160	0.160	0.072	0.101	0.161	0.114	0.076	0.156
	6.601	6.565	6.601	6.632	6.611	6.605	6.570	6.601
'e'								
EDGE SHARPNESS mm	0.0125	SQUARE	SQUARE	0.025	0.0125	0.0125	0.0125	0.0125

BEVEL ANGLE: DEGS

CONCENTRICITY 0.037mm

SURFACE FINISH (Ra) 1.02 microns

DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS

ROUNDNESS 0.021mm TAPER: 0 degs

DRAINHOLE PRESENT ? (YES/NO): No

COMMENTS:

INSPECTED BY... M Livingstone

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 01-OCT-2008

REF NO: OP80065

TEMPERATURE: 20 degsC

MEASURED ORIFICE BORE: 289.5805mm

PLATE DETAILS

PLATE SERIAL.	355-5	PLATE O.D	471.591mm		
MANUFACTURER:	DANIEL	PIPE I.D:	432.0604mm	SITE:	ALREWAS
MATERIAL CERT.No.		DESIGN BORE:	289.56mm	FLOW:	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		7	8
FLATNESS %	0.031	0.021	0.121	0.116	0.134	0.019	0.004	0.047
'E' mm	6.571	6.555	6.566	6.574	6.515	6.496	6.504	6.496
e' mm								
EDGE SHARPNESS mm	SQUARE	SQUARE	0.0125	0.0125	0.0125	0.0125	0.0125	SQUARE

BEVEL ANGLE:

CONCENTRICITY 0.386mm

SURFACE FINISH (Ra) 0.58 microns

DOWNSTREAM FACE/EDGE VISUAL INSPECTION PASS

ROUNDNESS : 0.019mm TAPER: 0 degs

DRAINHOLE PRESENT ? (YES/NO): No

COMMENTS: CLEAN PLATE.

INSPECTED BY..... M Livingstone

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 6-NOV-2009

REF NO: OP90047

TEMPERATURE: 20.5 degsC

MEASURED ORIFICE BORE: 289.589mm

PLATE DETAILS

PLATE SERIAL.	355-7	PLATE O.D	471.877mm		
MANUFACTURER:	DANIEL	PIPE I.D:	433.4415mm	SITE:	ALREWAS WM MTB
MATERIAL CERT.No	K92529	DESIGN BORE:	mm	FLOW:	M^3/DAY

TEST EQUIPMENT

MANUFACTURER & TYPE: KEMCO 700 MANUAL 3-DIMENSIONAL MEASURING MACHINE -ASSET NO OP-A02
CALIBRATED BY: QUALITY CONTROL TECHNOLOGY, UKAS TRACEABLE CERT:- 7325. NEXT CAL DUE:- 02-OCTOBER-2010

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS:	1	2	3		5	6		8
FLATNESS %	0.102	0.001	0.054	0.082	0.033	0.056	0.046	0.016
'E mm	9.624	9.636	9.647	9.635	9.637	9.644	9.625	9.603
'e mm	7.139	7.140	7.206	7.215	7.168	7.157	7.189	7.286
EDGE SHARPNESS mm	0.0125	0.0125	SQUARE	0.0125	SQUARE	0.0125	0.0125	0.0125

BEVEL ANGLE 36 DEGS

CONCENTRICITY 0.335mm

SURFACE FINISH (Ra) 0.45 microns

DOWNSTREAM FACE/EDGE VISUAL INSPECTION PASS

ROUNDNESS 0.011mm TAPER 0 degs

DRAINHOLE PRESENT ? (YES/NO): No

COMMENTS: CLEAN PLATE

INSPECTED BY.....M Livingstone

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 6-NOV-2009

REF NO: OP90048

TEMPERATURE: 20.4 degsC

MEASURED ORIFICE BORE: 289.4255mm

PLATE DETAILS

PLATE SERIAL.	360-5	PLATE O.D	455.539mm		
MANUFACTURER:	IGA	PIPE I.D:	432.064mm	SITE:	ALREWAS WM MTA
MATERIAL CERT.No	373901	DESIGN BORE:	mm	FLOW:	M^3/DAY

TEST EQUIPMENT

MANUFACTURER & TYPE: KEMCO 700 MANUAL 3-DIMENSIONAL MEASURING MACHINE -ASSET NO OP-A02
CALIBRATED BY: QUALITY CONTROL TECHNOLOGY, UKAS TRACEABLE CERT:- 7325. NEXT CAL DUE:- 02-OCTOBER-2010

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS:	1	2	3	4	5	6	7	8
FLATNESS %	0.061	0.007	0.130	0.195	0.089	0.052	0.192	0.182
'E mm	6.621	6.640	6.621	6.625	6.608	6.612	6.642	6.619
'e'								
EDGE SHARPNESS mm	0.0125	SQUARE	0.0125	0.025	0.0125	0.0125	0.0125	0.0125

BEVEL ANGLE DEGS

CONCENTRICITY 0.123mm

SURFACE FINISH (Ra) 0.58 microns

DOWNSTREAM FACE/EDGE VISUAL INSPECTION PASS

ROUNDNESS 0.030mm TAPER 0 degs

DRAINHOLE PRESENT ? (YES/NO) No

COMMENTS: CLEAN PLATE

INSPECTED BY ..... M Livingston

APPENDIX B
CORRECTED DAILY VOLUME FLOWS

TABLE B.1

FLOWS AT ALREWAS WM DURING THE PERIOD OF THE MIS-MEASUREMENT

	Original Values (total)	Corrected values (total)	% increase
Date	Volume (mscm)	Volume (mscm)	Volume (mscm)
12/5/2008	0.24206	**0.24219**	0.0530
13/5/2008	0.05941	**0.05948**	0.1158
14/5/2008	0.18903	**0.18926**	0.1223
15/5/2008	0.138	**0.13816**	0.1156
16/5/2008	0	**0.00000**	
17/5/2008	0	**0.00000**	
18/5/2008	0	**0.00000**	
19/5/2008	0.05701	**0.05708**	0.1164
20/5/2008	0.086	**0.08610**	0.1155
21/5/2008	0	**0.00000**	
22/5/2008	0	**0.00000**	
23/5/2008	0	**0.00000**	
24/5/2008	0	**0.00000**	
25/5/2008	0	**0.00000**	
26/5/2008	0.02002	**0.02004**	0.1166
27/5/2008	0	**0.00000**	
28/5/2008	0	**0.00000**	
29/5/2008	0	**0.00000**	
30/5/2008	0	**0.00000**	
31/5/2008	0	**0.00000**	
1/6/2008	0	**0.00000**	
2/6/2008	0.01898	**0.01900**	0.1166
3/6/2008	0	**0.00000**	
4/6/2008	0	**0.00000**	
5/6/2008	0	**0.00000**	
6/6/2008	0	**0.00000**	
7/6/2008	0	**0.00000**	
8/6/2008	0	**0.00000**	
9/6/2008	0	**0.00000**	
10/6/2008	0	**0.00000**	
11/6/2008	0	**0.00000**	
12/6/2008	0	**0.00000**	
13/6/2008	0	**0.00000**	
14/6/2008	0	**0.00000**	
15/6/2008	0	**0.00000**	
16/6/2008	0	**0.00000**	
17/6/2008	0	**0.00000**	
18/6/2008	0	**0.00000**	
19/6/2008	0	**0.00000**	
20/6/2008	0	**0.00000**	

21/6/2008	0	**0.00000**	
22/6/2008	0	**0.00000**	
23/6/2008	0	**0.00000**	
24/6/2008	0	**0.00000**	
25/6/2008	0	**0.00000**	
26/6/2008	0	**0.00000**	
27/6/2008	0	**0.00000**	
28/6/2008	0	**0.00000**	
29/6/2008	0	**0.00000**	
30/6/2008	0	**0.00000**	
1/7/2008	0	**0.00000**	
2/7/2008	0.18799	**0.18821**	0.1166
3/7/2008	0	**0.00000**	
4/7/2008	0	**0.00000**	
5/7/2008	0	**0.00000**	
6/7/2008	0	**0.00000**	
7/7/2008	0	**0.00000**	
8/7/2008	0	**0.00000**	
9/7/2008	0	**0.00000**	
10/7/2008	0	**0.00000**	
11/7/2008	0	**0.00000**	
12/7/2008	0	**0.00000**	
13/7/2008	0	**0.00000**	
14/7/2008	0	**0.00000**	
15/7/2008	0	**0.00000**	
16/7/2008	0	**0.00000**	
17/7/2008	0	**0.00000**	
18/7/2008	0	**0.00000**	
19/7/2008	0	**0.00000**	
20/7/2008	0	**0.00000**	
21/7/2008	0	**0.00000**	
22/7/2008	0	**0.00000**	
23/7/2008	0	**0.00000**	
24/7/2008	0	**0.00000**	
25/7/2008	0	**0.00000**	
26/7/2008	0.00098	**0.00098**	0.1166
27/7/2008	0	**0.00000**	
28/7/2008	0	**0.00000**	
29/7/2008	0	**0.00000**	
30/7/2008	0	**0.00000**	
31/7/2008	0	**0.00000**	
1/8/2008	0	**0.00000**	
2/8/2008	0	**0.00000**	
3/8/2008	0	**0.00000**	
4/8/2008	0	**0.00000**	
5/8/2008	0	**0.00000**	
6/8/2008	0	**0.00000**	
7/8/2008	0	**0.00000**	
8/8/2008	0	**0.00000**	

9/8/2008	0	**0.00000**	
10/8/2008	0	**0.00000**	
11/8/2008	0	**0.00000**	
12/8/2008	0	**0.00000**	
13/8/2008	0	**0.00000**	
14/8/2008	0	**0.00000**	
15/8/2008	0	**0.00000**	
16/8/2008	0	**0.00000**	
17/8/2008	0	**0.00000**	
18/8/2008	0	**0.00000**	
19/8/2008	0	**0.00000**	
20/8/2008	0	**0.00000**	
21/8/2008	0	**0.00000**	
22/8/2008	0	**0.00000**	
23/8/2008	0	**0.00000**	
24/8/2008	0	**0.00000**	
25/8/2008	0	**0.00000**	
26/8/2008	0.08301	**0.08311**	0.1171
27/8/2008	0	**0.00000**	
28/8/2008	0	**0.00000**	
29/8/2008	0	**0.00000**	
30/8/2008	0	**0.00000**	
31/8/2008	0	**0.00000**	
1/9/2008	0	**0.00000**	
2/9/2008	0	**0.00000**	
3/9/2008	0	**0.00000**	
4/9/2008	0	**0.00000**	
5/9/2008	0	**0.00000**	
6/9/2008	0	**0.00000**	
7/9/2008	0	**0.00000**	
8/9/2008	0	**0.00000**	
9/9/2008	0	**0.00000**	
10/9/2008	0	**0.00000**	
11/9/2008	0	**0.00000**	
12/9/2008	0	**0.00000**	
13/9/2008	0	**0.00000**	
14/9/2008	0	**0.00000**	
15/9/2008	0	**0.00000**	
16/9/2008	0	**0.00000**	
17/9/2008	0	**0.00000**	
18/9/2008	0	**0.00000**	
19/9/2008	0	**0.00000**	
20/9/2008	0	**0.00000**	
21/9/2008	0	**0.00000**	
22/9/2008	0	**0.00000**	
23/9/2008	0	**0.00000**	
24/9/2008	0	**0.00000**	
25/9/2008	0	**0.00000**	
26/9/2008	0	**0.00000**	

27/9/2008	0	**0.00000**	
28/9/2008	0	**0.00000**	
29/9/2008	0.00604	**0.00605**	0.1166
30/9/2008	0.02295	**0.02298**	0.1117
1/10/2008	0	**0.00000**	
2/10/2008	0	**0.00000**	
3/10/2008	0	**0.00000**	
4/10/2008	0.85004	**0.85102**	0.1157
5/10/2008	0	**0.00000**	
6/10/2008	0.48297	**0.48353**	0.1163
7/10/2008	0	**0.00000**	
8/10/2008	0	**0.00000**	
9/10/2008	0	**0.00000**	
10/10/2008	0	**0.00000**	
11/10/2008	0	**0.00000**	
12/10/2008	0	**0.00000**	
13/10/2008	0	**0.00000**	
14/10/2008	0	**0.00000**	
15/10/2008	0	**0.00000**	
16/10/2008	0	**0.00000**	
17/10/2008	0	**0.00000**	
18/10/2008	0	**0.00000**	
19/10/2008	0	**0.00000**	
20/10/2008	0	**0.00000**	
21/10/2008	0	**0.00000**	
22/10/2008	0	**0.00000**	
23/10/2008	0	**0.00000**	
24/10/2008	0	**0.00000**	
25/10/2008	0.38898	**0.38943**	0.1161
26/10/2008	0	**0.00000**	
27/10/2008	1.84998	**1.85214**	0.1170
28/10/2008	1.68402	**1.68598**	0.1161
29/10/2008	4.56799	**4.57332**	0.1168
30/10/2008	0.73804	**0.73890**	0.1161
31/10/2008	1.10999	**1.11128**	0.1161
1/11/2008	2.07202	**2.07444**	0.1167
2/11/2008	1.02295	**1.02414**	0.1161
3/11/2008	0.93604	**0.93713**	0.1160
4/11/2008	0	**0.00000**	
5/11/2008	0.00397	**0.00397**	0.1166
6/11/2008	0	**0.00000**	
7/11/2008	0.40204	**0.40251**	0.1162
8/11/2008	0	**0.00000**	
9/11/2008	1.95801	**1.96028**	0.1159
10/11/2008	5.47699	**5.48336**	0.1164
11/11/2008	5.255	**5.26110**	0.1162
12/11/2008	5.16199	**5.16799**	0.1163
13/11/2008	3.88501	**3.88952**	0.1160
14/11/2008	0	**0.00000**	

15/11/2008	0	**0.00000**	
16/11/2008	0	**0.00000**	
17/11/2008	2.008	**2.01033**	0.1159
18/11/2008	4.56299	**4.56829**	0.1161
19/11/2008	5.091	**5.09703**	0.1185
20/11/2008	0.00702	**0.00703**	0.1171
21/11/2008	4.474	**4.47920**	0.1163
22/11/2008	4.64398	**4.64938**	0.1162
23/11/2008	4.75897	**4.76450**	0.1161
24/11/2008	5.11005	**5.11598**	0.1161
25/11/2008	5.42798	**5.43449**	0.1200
26/11/2008	4.35797	**4.36322**	0.1206
27/11/2008	4.48206	**4.48746**	0.1206
28/11/2008	5.35797	**5.36443**	0.1205
29/11/2008	4.98102	**4.98701**	0.1204
30/11/2008	5.10699	**5.11314**	0.1204
1/12/2008	5.71301	**5.71989**	0.1205
2/12/2008	5.55798	**5.56469**	0.1207
3/12/2008	6.005	**6.01224**	0.1205
4/12/2008	5.51099	**5.51763**	0.1205
5/12/2008	4.90399	**4.90990**	0.1205
6/12/2008	4.68103	**4.68666**	0.1202
7/12/2008	6.16901	**6.17645**	0.1205
8/12/2008	4.914	**4.91993**	0.1206
9/12/2008	5.35498	**5.36143**	0.1205
10/12/2008	5.40997	**5.41649**	0.1205
11/12/2008	5.55005	**5.55674**	0.1206
12/12/2008	5.60297	**5.60969**	0.1199
13/12/2008	4.78802	**4.79378**	0.1203
14/12/2008	5.40796	**5.41448**	0.1205
15/12/2008	4.80603	**4.81181**	0.1204
16/12/2008	5.41602	**5.42254**	0.1205
17/12/2008	5.19501	**5.20127**	0.1206
18/12/2008	4.82599	**4.83180**	0.1205
19/12/2008	4.60498	**4.61052**	0.1204
20/12/2008	3.66498	**3.66941**	0.1208
21/12/2008	0	**0.00000**	
22/12/2008	0	**0.00000**	
23/12/2008	0	**0.00000**	
24/12/2008	0	**0.00000**	
25/12/2008	0	**0.00000**	
26/12/2008	0	**0.00000**	
27/12/2008	4.92004	**4.92560**	0.1129
28/12/2008	4.552	**4.55737**	0.1181
29/12/2008	5.32098	**5.32739**	0.1204
30/12/2008	5.65997	**5.66679**	0.1206
31/12/2008	5.77301	**5.77996**	0.1204
1/1/2009	5.49799	**5.50461**	0.1204
2/1/2009	5.10901	**5.11518**	0.1207

3/1/2009	5.17804	**5.18427**	0.1202
4/1/2009	5.505	**5.51164**	0.1207
5/1/2009	5.30096	**5.30734**	0.1204
6/1/2009	5.79602	**5.80297**	0.1200
7/1/2009	5.78998	**5.79693**	0.1199
8/1/2009	5.94702	**5.95416**	0.1201
9/1/2009	5.186	**5.19221**	0.1198
10/1/2009	5.461	**5.46755**	0.1199
11/1/2009	4.79	**4.79573**	0.1195
12/1/2009	5.476	**5.48256**	0.1198
13/1/2009	5.236	**5.24227**	0.1198
14/1/2009	5.621	**5.62773**	0.1198
15/1/2009	4.837	**4.84279**	0.1198
16/1/2009	5.429	**5.43551**	0.1198
17/1/2009	5.084	**5.09010**	0.1199
18/1/2009	4.896	**4.90186**	0.1197
19/1/2009	5.793	**5.79995**	0.1199
20/1/2009	5.856	**5.86303**	0.1200
21/1/2009	5.214	**5.22024**	0.1197
22/1/2009	5.20901	**5.21526**	0.1200
23/1/2009	5.685	**5.69181**	0.1198
24/1/2009	5.118	**5.12414**	0.1199
25/1/2009	4.80801	**4.81375**	0.1195
26/1/2009	5.61	**5.61673**	0.1199
27/1/2009	4.988	**4.99394**	0.1192
28/1/2009	5.228	**5.23424**	0.1194
29/1/2009	5.656	**5.66278**	0.1199
30/1/2009	5.508	**5.51459**	0.1196
31/1/2009	5.191	**5.19719**	0.1193
1/2/2009	5.72199	**5.72882**	0.1193
2/2/2009	6.94501	**6.95333**	0.1199
3/2/2009	6.87199	**6.88023**	0.1198
4/2/2009	5.806	**5.81292**	0.1191
5/2/2009	6.265	**6.27236**	0.1174
6/2/2009	5.395	**5.40143**	0.1193
7/2/2009	5.08301	**5.08906**	0.1190
8/2/2009	5.35399	**5.36036**	0.1190
9/2/2009	6.03001	**6.03720**	0.1192
10/2/2009	5.81799	**5.82494**	0.1194
11/2/2009	5.812	**5.81893**	0.1193
12/2/2009	5.58	**5.58665**	0.1191
13/2/2009	4.93901	**4.94487**	0.1186
14/2/2009	5.11499	**5.12107**	0.1188
15/2/2009	4.75	**4.75562**	0.1184
16/2/2009	5.14101	**5.14711**	0.1187
17/2/2009	5.039	**5.04498**	0.1188
18/2/2009	4.86099	**4.86675**	0.1185
19/2/2009	4.737	**4.74261**	0.1185
20/2/2009	4.60201	**4.60745**	0.1182

21/2/2009	4.636	**4.64149**	0.1183
22/2/2009	4.549	**4.55437**	0.1181
23/2/2009	4.95	**4.95588**	0.1188
24/2/2009	4.75	**4.75563**	0.1186
25/2/2009	5.15302	**5.15918**	0.1195
26/2/2009	5.091	**5.09708**	0.1194
27/2/2009	4.88998	**4.89581**	0.1193
28/2/2009	4.92599	**4.93186**	0.1192
1/3/2009	4.55002	**4.55545**	0.1193
2/3/2009	5.28598	**5.29230**	0.1196
3/3/2009	5.42001	**5.42649**	0.1196
4/3/2009	5.448	**5.45452**	0.1197
5/3/2009	4.88901	**4.89485**	0.1194
6/3/2009	5.17798	**5.18417**	0.1196
7/3/2009	0.17499	**0.17509**	0.0579
8/3/2009	4.83301	**4.83861**	0.1159
9/3/2009	5.091	**5.09702**	0.1182
10/3/2009	3.62	**3.62435**	0.1201
11/3/2009	0	**0.00000**	
12/3/2009	0	**0.00000**	
13/3/2009	0.00198	**0.00198**	0.1166
14/3/2009	0	**0.00000**	
15/3/2009	0	**0.00000**	
16/3/2009	0	**0.00000**	
17/3/2009	0.07101	**0.07109**	0.1178
18/3/2009	0	**0.00000**	
19/3/2009	0	**0.00000**	
20/3/2009	0	**0.00000**	
21/3/2009	0	**0.00000**	
22/3/2009	0	**0.00000**	
23/3/2009	1.979	**1.98130**	0.1163
24/3/2009	0	**0.00000**	
25/3/2009	0	**0.00000**	
26/3/2009	0.41898	**0.41947**	0.1158
27/3/2009	0	**0.00000**	
28/3/2009	0	**0.00000**	
29/3/2009	0	**0.00000**	
30/3/2009	1.77902	**1.78108**	0.1159
31/3/2009	3.07599	**3.07956**	0.1161
1/4/2009	0	**0.00000**	
2/4/2009	0	**0.00000**	
3/4/2009	0	**0.00000**	
4/4/2009	0	**0.00000**	
5/4/2009	0	**0.00000**	
6/4/2009	0	**0.00000**	
7/4/2009	0	**0.00000**	
8/4/2009	0	**0.00000**	
9/4/2009	0	**0.00000**	
10/4/2009	0	**0.00000**	

11/4/2009	0	**0.00000**	
12/4/2009	0	**0.00000**	
13/4/2009	0	**0.00000**	
14/4/2009	0	**0.00000**	
15/4/2009	0	**0.00000**	
16/4/2009	0.065	**0.06508**	0.1181
17/4/2009	0	**0.00000**	
18/4/2009	0	**0.00000**	
19/4/2009	0	**0.00000**	
20/4/2009	0	**0.00000**	
21/4/2009	0	**0.00000**	
22/4/2009	0	**0.00000**	
23/4/2009	0	**0.00000**	
24/4/2009	0	**0.00000**	
25/4/2009	0	**0.00000**	
26/4/2009	0	**0.00000**	
27/4/2009	0	**0.00000**	
28/4/2009	0	**0.00000**	
29/4/2009	0	**0.00000**	
30/4/2009	0	**0.00000**	
1/5/2009	0	**0.00000**	
2/5/2009	0	**0.00000**	
3/5/2009	0	**0.00000**	
4/5/2009	0.00601	**0.00602**	0.1152
5/5/2009	0.186	**0.18622**	0.1160