ASSESSMENT OF ERROR DUE TO ORIFICE DIAMETER MIS-MEASUREMENT AT PETERS GREEN 2

A Report for

National Grid
Brick Kiln Street
HINCKLEY
Leicestershire
LE10 0NA

PROJECT NO: NGR010 **REPORT NO: 2010/249** **DATE: 17 JUNE 2010**

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TUV NEL Ltd
East Kilbride
GLASGOW G75 0QF
UK
Tel: +44 (0)1355 220222
Fax: +44 (0)1355 272999
www.tuvnel.com

Assessment of Error Due to Orifice Diameter Mis-measurement at Peters Green 2

A Report for

National Grid
Brick Kiln Street
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Leicestershire
LE10 0NA

Prepared by:	Approved by:
M.J. Reader-Harris	J.M. McNaught
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 Peters Green 2 correction factors should be applied as follows:

Meter tube	Date	Correction factor $q_{m,c}/q_{m,o}$
MTC	21/06/2007 to 08/09/2008	1.001966
MTD	22/02/2008 to 08/09/2008	1.002007

Over the period 21/06/2007 to 08/09/2008 inclusive the flow and corrected flow in the two tubes were as follows:

	MTC	MTD
Flow (mscm)	2008.58519	796.57067
Corrected flow (mscm)	2012.52700	797.11513

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 Peters Green 2 in the period of the error. The Joint Office Error Codes are NT006 and NT007 for meter tubes MTC and MTD.

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)
OP5077	PGRN-SM-2510-B-1	26/04/05	326.647	21	326.6418
OP5081	PGRN-SM-2510-A-1	05/05/05	326.6745	21	326.6693
OP70069	PGRN-SM-2510-A-1	21/06/07	326.3955	21	326.3903
OP70072	PGRN-SM-3520-A-2	22/06/07	326.0855	21	326.0803
OP70073	PGRN-SM-3520-B-2	22/06/07	326.4545	21	326.4493
OP70074	PGRN-SM-3520-B-1	28/06/07	326.3525	20	326.3525
OP80040	PGRN-SM-3520-A-2	16/07/08	326.6075	20	326.6075
OP80041	PGRN-SM-3520-B-2	18/07/08	326.6205	20	326.6205
OP90004	PGRN-SM-2510-A-1	05/02/09	326.687	20.1	326.6865
OP90005	PGRN-SM-2510-B-1	06/02/09	326.6505	20.1	326.6500
OP90022	PGRN-SM-3520-A-2	29/10/09	326.611	20.4	326.6089
OP90023	PGRN-SM-3520-B-2	16/06/09	326.6215	20.5	326.6189

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. OP70072 was not used and would have given a much larger mis-measurement than other mis-measured plates. OP70074 gives a much larger measurement of edge radius than other certificates for this plate.

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

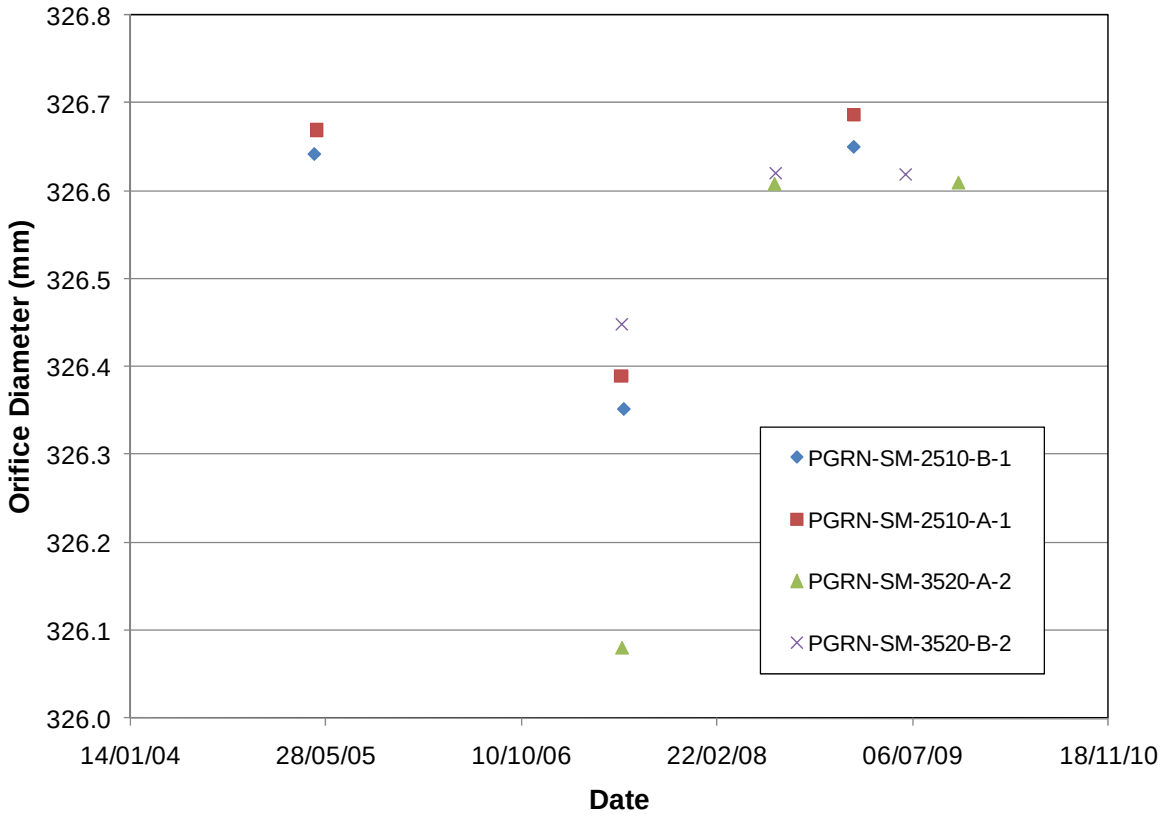

Figure 1 Orifice Diameters at 20 °C

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 –PART 1

Configuration data	omnM0418.cfg	omnM0621.cfg	omnM0628.cfg
MTC	18/04/2007 23:31	21/06/2007 23:31	28/06/2007 23:31
Orifice plate bore diameter (mm)	326.6745	326.3955	326.3955
Expansion coefficient of the plate (/°C)	0.000016	0.000016	0.000016
Orifice plate calibration temperature	21	21	21
Meter tube diameter (mm)	582.1775	582.1775	582.1775
Expansion coefficient of the meter tube (/°C)	0.000011	0.000011	0.000011
Meter tube calibration temperature	19	19	19
Isentropic Exponent	1.3429	1.3429	1.3429
Dynamic Viscosity (Pa.s)	0.0000119	0.0000119	0.0000119
Orifice plate certificate number	OP5081	OP70069	OP70069
Orifice plate serial number	PGRN-SM-2510-A-1	PGRN-SM-2510-A-1	PGRN-SM-2510-A-1
Error in orifice diameter?	No	Yes	Yes
MTD			
Orifice plate bore diameter (mm)	326.647	326.647	326.647
Expansion coefficient of the plate (/°C)	0.000016	0.000016	0.000016
Orifice plate calibration temperature	21	21	20
Meter tube diameter (mm)	581.1942	581.1942	581.1942
Expansion coefficient of the meter tube (/°C)	0.000011	0.000011	0.000011
Meter tube calibration temperature	17	17	17
Isentropic Exponent	1.3429	1.3429	1.3429
Dynamic Viscosity (Pa.s)	0.0000119	0.0000119	0.0000119
Orifice plate certificate number	OP5077	OP5077	OP5077
Orifice plate serial number	PGRN-SM-2510-B-1	PGRN-SM-2510-B-1	PGRN-SM-2510-B-1
Error in orifice diameter?	No	No	No

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

Configuration data	omnN0222.cfg	omnN0331.cfg	omnN0908.cfg
MTC	23/02/2008 00:31	31/03/2008 23:31	08/09/2008 23:31
Orifice plate bore diameter (mm)	326.3955	326.3955	326.6075
Expansion coefficient of the plate (/°C)	0.000016	0.000016	0.000016
Orifice plate calibration temperature	21	21	20
Meter tube diameter (mm)	582.1775	582.1775	582.1775
Expansion coefficient of the meter tube (/°C)	0.000011	0.000011	0.000011
Meter tube calibration temperature	19	19	19
Isentropic Exponent	1.3429	1.343967	1.343967
Dynamic Viscosity (Pa.s)	0.0000119	0.0000119	0.0000119
Orifice plate certificate number	OP70069	OP70069	OP80040
Orifice plate serial number	PGRN-SM-2510-A-1	PGRN-SM-2510-A-1	PGRN-SM-2510-A-2
Error in orifice diameter?	Yes	Yes	No
MTD			
Orifice plate bore diameter (mm)	326.3525	326.3525	326.6205
Expansion coefficient of the plate (/°C)	0.000016	0.000016	0.000016
Orifice plate calibration temperature	20	20	20
Meter tube diameter (mm)	581.1942	581.1942	581.1942
Expansion coefficient of the meter tube (/°C)	0.000011	0.000011	0.000011
Meter tube calibration temperature	17	17	17
Isentropic Exponent	1.3429	1.343967	1.343967
Dynamic Viscosity (Pa.s)	0.0000119	0.0000119	0.0000119
Orifice plate certificate number	OP70074	OP70074	OP80041
Orifice plate serial number	PGRN-SM-2510-B-1	PGRN-SM-2510-B-1	PGRN-SM-2510-B-2
Error in orifice diameter?	Yes	Yes	No

In the configuration files for MTD the orifice plate calibration temperature has been entered wrongly on 28/06/2007. The calculations given here give the correction due to mis-measurement of orifice diameter alone, not that due to this other error.

It is noticeable that for this meter station the plates may be removed, recalibrated and inserted without inserting a different replacement plate.

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 0.00002% at maximum.

Over the period from 21/06/2007 to 31/03/2008 the correction on MTC can be calculated as in Table 3. Throughout this calculation the meter tube diameter is 582.2 mm, the isentropic exponent is 1.3429 and the dynamic viscosity is 0.0000119 Pa s.

TABLE 3

THE CORRECTION ON MTC FROM 21/06/2007 TO 31/03/2008

	d mm	β	ε	Re_D	C	$\frac{q_{m,c}}{q_{m,o}}$
Original: Δp=10 mbar	326.3903	0.560631	0.999941	3074098	0.603825	
Corrected Δp=10 mbar	326.6779	0.561125	0.999941	3080142	0.603830	1.0019663
Original Δp=500 mbar	326.3903	0.560631	0.997044	21666068	0.603599	
Corrected Δp=500 mbar	326.6779	0.561125	0.997043	21708646	0.603604	1.0019652

So $q_{m,c}/q_{m,o}$ is 1.001966.

Over the period from 22/02/2008 to 31/03/2008 the correction on MTD can be calculated as in Table 4. Throughout this calculation the meter tube diameter is 581.2 mm, the isentropic exponent is 1.3429 and the dynamic viscosity is 0.0000119 Pa s.

TABLE 4

THE CORRECTION ON MTD FROM 22/02/2008 TO 31/03/2008

	d mm	β	ε	Re_D	C	$\frac{q_{m,c}}{q_{m,o}}$
Original: Δp=10 mbar	326.3525	0.561502	0.999941	3079624	0.603835	
Corrected Δp=10 mbar	326.6459	0.562007	0.999941	3085805	0.603841	1.0020072
Original Δp=500 mbar	326.3525	0.561502	0.997043	21704963	0.603609	
Corrected Δp=500 mbar	326.6459	0.562007	0.997042	21748506	0.603614	1.0020061

So $q_{m,c}/q_{m,o}$ is 1.002007.

Over the period from 31/03/2008 to 08/09/2008 the correction on MTC can be calculated as in Table 5. Throughout this calculation the meter tube diameter is 582.2 mm, the isentropic exponent is 1.343967 and the dynamic viscosity is 0.0000119 Pa s.

TABLE 5

THE CORRECTION ON MTC FROM 31/03/2008 TO 08/09/2008

	d mm	β	ε	Re_D	C	$\frac{q_{m,c}}{q_{m,o}}$
Original: Δp=10 mbar	326.3903	0.560631	0.999941	3074098	0.603825	
Corrected Δp=10 mbar	326.6779	0.561125	0.999941	3080143	0.603830	1.0019663
Original Δp=500 mbar	326.3903	0.560631	0.997046	21666119	0.603599	
Corrected Δp=500 mbar	326.6779	0.561125	0.997046	21708697	0.603604	1.0019652

So $q_{m,c}/q_{m,o}$ is 1.001966.

Over the period from 31/03/2008 to 08/09/2008 the correction on MTD can be calculated as in Table 6. Throughout this calculation the meter tube diameter is 581.2 mm, the isentropic exponent is 1.343967 and the dynamic viscosity is 0.0000119 Pa s.

TABLE 6

THE CORRECTION ON MTD FROM 31/03/2008 TO 08/09/2008

	d mm	β	ε	Re_D	C	$\frac{q_{m,c}}{q_{m,o}}$
Original: Δp=10 mbar	326.3525	0.561502	0.999941	3079624	0.603835	
Corrected Δp=10 mbar	326.6459	0.562007	0.999941	3085805	0.603841	1.0020072
Original Δp=500 mbar	326.3525	0.561502	0.997045	21705014	0.603609	
Corrected Δp=500 mbar	326.6459	0.562007	0.997044	21748557	0.603614	1.0020061

So $q_{m,c}/q_{m,o}$ is 1.002007.

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 MTC 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 MTC to the sum of the calculated flows in the tubes. Intervals in which the calculated flow in both MTD and MTD 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 MTC (obtained by summing the flows in each interval) and that in MTD (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 21/06/2007 the orifice plate in MTA was changed at 09:30, that on 22/02/2008 the orifice plate in MTB was changed at 08:00, and that on 08/09/2008 the orifice plates in MTA and MTB were changed at 10:00 and 08:00 respectively.

5 CONCLUSIONS

Correction factors should be applied as shown in Table 7.

TABLE 7

CORRECTION FACTORS

Meter tube	Date	Correction factor $q_{m,c}/q_{m,o}$
MTC	21/06/2007 to 08/09/2008	1.001966
MTD	22/02/2008 to 08/09/2008	1.002007

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 21/06/2007 TO 08/09/2008 INCLUSIVE

	MTC	MTD
Flow (mscm)	2008.58519	796.57067
Correction (mscm)	3.94181	0.54446
Corrected flow (mscm)	2012.52700	797.11513
% change	0.1962	0.0684

APPENDIX A
ORIFICE PLATE CALIBRATION CERTIFICATES

TRANSCO ORIFICE PLATE CALIBRATION

DATE: ***26-04-05***

REF NO: ***OP5077***

TEMPERATURE: ***21 degsC***

MEASURED ORIFICE BORE: ***326.647mm***

PLATE DETAILS

PLATE SERIAL.	PGRN-SM-2510-B-1	PLATE O.D	647.703mm		
MANUFACTURER:		PIPE I.D:	mm	SITE:	PETERS GREEN SM
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:- 15/10/05

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS:		2	3	4	5			
FLATNESS	0.023	0.055	0.067	0.059	0.052	0.051	0.028	0.006
'E' mm	25.521	25.510	25.516	25.511	25.509	25.508	25.517	25.528
'e' mm	10.098	10.124	10.157	10.094	10.006	10.001	10.039	10.020
EDGE SHARPNESS mm	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025

BEVEL ANGLE: 37 DEGS

CONCENTRICITY 0.052mm

SURFACE FINISH (Ra) 2.5 microns

DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS

ROUNDNESS 0.013mm TAPER: 0 degs

COMMENTS:

INSPECTED BY..... G.WARDLE

VERIFIED BY ..... P.KENNERSON

TRANSCO ORIFICE PLATE CALIBRATION

DATE: 05-05-05

REF NO: OP5081

TEMPERATURE: 21 degsC

MEASURED ORIFICE BORE: 326.6745mm

PLATE DETAILS

PLATE SERIAL.	PGRN-SM-2510-A-1	PLATE O.D	647.698mm		
MANUFACTURER:		PIPE I.D:	mm	SITE:	PETERS GREEN SM
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:- 15/10/05

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS:-	1	2	3	4	5	6		
FLATNESS %	0.011	0.006	0.012	0.006	0.026	0.022	0.017	0.007
'E' mm	25.504	25.511	25.501	25.495	25.509	25.514	25.494	25.500
mm	9.367	9.328	9.313	9.321	9.361	9.377	9.418	9.423
EDGE SHARPNESS mm	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025

BEVEL ANGLE: 37 DEGS

CONCENTRICITY 0.125mm

SURFACE FINISH (Ra) 3.0 microns

DOWNSTREAM FACE/EDGE VISUAL INSPECTION PASS

ROUNDNESS 0.010mm TAPER: 0 degs

COMMENTS:

INSPECTED BY ..... G.WARDLE

VERIFIED BY ..... P.KENNERSON

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 21-06-07

REF NO: OP70069

TEMPERATURE: 21 degsC

MEASURED ORIFICE BORE: 326.3955mm

PLATE DETAILS

PLATE SERIAL.	PGRN-5M-2510-A-1	PLATE O.D	647.178mm		
MANUFACTURER:		PIPE I.D:	mm	SITE:	PETERS GREEN
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	6	7	8
FLATNESS %	0.000	0.012	0.001	0.015	0.008	0.029	0.002	0.018
'E' mm	25.549	25.490	25.490	25.556	25.556	25.500	25.494	25.538
e' mm	9.429	9.309	9.294	9.352	9.362	9.369	9.384	9.429
EDGE SHARPNESS mm	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125

BEVEL ANGLE 37 DEGS

CONCENTRICITY 0.107mm

SURFACE FINISH (Ra) 2.3 microns

DOWNSTREAM FACE/EDGE VISUAL INSPECTION PASS

ROUNDNESS 0.301mm TAPER: 0 degs

COMMENTS

INSPECTED BY. J. CHALLEN

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 22-06-07

REF NO: OP70072

TEMPERATURE: 21 degsC

MEASURED ORIFICE BORE: 326.0855mm

PLATE DETAILS

PLATE SERIAL.	PGRN-SM-3520-A-2	PLATE O.D	647.320mm		
MANUFACTURER:	ANT	PIPE I.D:	mm	SITE:	PETERS GREEN
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	6	7	8
FLATNESS %	0.018	0.067	0.091	0.048	0.023	0.008	0.112	0.065
'E' mm	25.252	25.199	25.193	25.248	25.265	25.206	25.209	25.242
	8.570	8.512	8.513	8.673	8.579	8.533	8.520	8.559
EDGE SHARPNESS mm	SQUARE	SQUARE	0.0125	0.0125	SQUARE	SQUARE	SQUARE	SQUARE

BEVEL ANGLE 34 DEGS

CONCENTRICITY 0.074mm

SURFACE FINISH (Ra) 0.6 microns

DOWNSTREAM FACE/EDGE VISUAL INSPECTION PASS

ROUNDNESS 0.307mm TAPER: 11 degs

COMMENTS:

INSPECTED BY.

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 22-06-07

REF NO: OP70073

TEMPERATURE: 21 degsC

MEASURED ORIFICE BORE: 326.4545mm

PLATE DETAILS

PLATE SERIAL.	PGRN-S5-3520-B-2	PLATE O.D	647.424mm		
MANUFACTURER:	ANT	PIPE I.D:	mm	SITE:	PETERS GREEN
MATERIAL CERT.No		DESIGN BORE:	mm	FLOW:	

TEST EQUIPMENT

MANUFACTURER & TYPE: KEMCO 700 MANUAL 3-DIMENSIONAL MEASURING MACHINE -ASSET NO OP-A0:
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 %	0.052	0.049	0.061	0.142	0.182	0.129	0.110	0.066
'E' mm	25.328	25.272	25.259	25.325	25.330	25.259	25.260	25.338
'e' mm	8.639	8.523	8.496	8.498	8.511	8.430	8.453	8.519
EDGE SHARPNESS mm	SQUARE	SQUARE	SQUARE	SQUARE	SQUARE	0.0125	0.0125	SQUARE

BEVEL ANGLE: 34 DEGS

CONCENTRICITY 0.025mm

SURFACE FINISH (Ra) 0.5 microns

DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS

ROUNDNESS : 0.291mm TAPER: .06 degs

COMMENTS

INSPECTED BY

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 28-06-2007

REF NO: OP70074

TEMPERATURE: 20 degsC

MEASURED ORIFICE BORE: 326.3525mm

PLATE DETAILS

PLATE SERIAL. PGRN-SM-2510-B-1
MANUFACTURER:
MATERIAL CERT.No.

PLATE O.D 647.182mm
PIPE I.D: mm
DESIGN BORE: mm

SITE: PETERS GREEN SM
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	6	7	8
FLATNESS %	0.007	0.040	0.068	0.062	0.054	0.047	0.042	0.017
'E' mm	25.565	25.496	25.492	25.562	25.564	25.503	25.508	25.569
'e' mm	10.115	10.111	10.126	10.121	10.050	10.019	10.031	10.071
EDGE SHARPNESS mm	0.5	0.5	1	0.5	0.5	1	0.5	1

BEVEL ANGLE: 37 DEGS

CONCENTRICITY 0.065mm

SURFACE FINISH (Ra) 2 microns

DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS

ROUNDNESS : 0.294mm TAPER: 0 degs

COMMENTS:

INSPECTED BY.....

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 16-JULY-2008

REF NO: OP80040

TEMPERATURE: 20 degsC

MEASURED ORIFICE BORE: 326.6075mm

PLATE DETAILS

PLATE SERIAL.	PGRN-SM-3520-A-2	PLATE O.D	648.049mm		
MANUFACTURER:	ANT	PIPE I.D:	582.1775mm	SITE:	PETERS GREEN SM
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, 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 %	0.024	0.065	0.095	0.036	0.030	0.026	0.104	0.072
'E' mm	25.198	25.203	25.212	25.188	25.214	25.219	25.207	25.16
'e' mm	8.551	8.547	8.530	8.534	8.538	8.530	8.519	8.502
EDGE SHARPNESS mm	SQUARE	SQUARE	0.0125	SQUARE	SQUARE	0.0125	0.0125	SQUARE

BEVEL ANGLE: 34 DEGS

CONCENTRICITY 0.024mm

SURFACE FINISH (Ra) 0.7 microns

DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS

ROUNDNESS : 0.016mm TAPER 0 degs

DRAINHOLE PRESENT ? (YES/NO): No

COMMENTS

INSPECTED BY. ..... M Livingstone.

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 18-JULY-2008

REF NO: OP80041

TEMPERATURE: 20 degsC

MEASURED ORIFICE BORE: 326.6205mm

PLATE DETAILS

PLATE SERIAL.	PGRN-SM-3520-B-2	PLATE O.D	647.973mm		
MANUFACTURER:	ANT	PIPE I.D:	581.1942mm	SITE:	PETERS GREEN SM - B
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, UKAS CERT:- 6292. NEXT CAL DUE:- 05-OCTOBER-2008

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS:-	1	2	3	4	5	6		
FLATNESS %	0.085	0.071	0.061	0.089	0.172	0.187	0.129	0.118
'E' mm	25.290	25.304	25.291	25.270	25.262	25.262	25.252	25.270
'e' mm	8.538	8.537	8.530	8.468	8.440	8.430	8.452	8.481
EDGE SHARPNESS mm	0.0125	0.0125	SQUARE	SQUARE	SQUARE	SQUARE	SQUARE	SQUARE

BEVEL ANGLE: 34 DEGS

CONCENTRICITY 0.090mm

SURFACE FINISH (Ra) 0.7 microns

DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS

ROUNDNESS 0.006mm TAPER: 0 degs

DRAINHOLE PRESENT ? (YES/NO): No

COMMENTS:

INSPECTED BY M Livingstone

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 05-FEB-2009

REF NO: OP90004

TEMPERATURE: 20.1 degsC

MEASURED ORIFICE BORE: 326.687mm

PLATE DETAILS

PLATE SERIAL.	PGRN-SM-2510-A-1	PLATE O.D	647.712mm		
MANUFACTURER:	HEECO	PIPE I.D:	582.1775mm	SITE:	PETERS GREEN SM
MATERIAL CERT.No.	7273	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 CERT:- 6822. NEXT CAL DUE:- 03-OCTOBER-2009

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS:	1	2	3	4	5		7	8
FLATNESS %	0.004	0.006	0.002	0.012	0.012	0.028	0.005	0.019
	25.514	25.501	25.492	25.460	25.485	25.507	25.480	25.497
'e' mm	9.370	9.329	9.303	9.296	9.332	9.375	9.417	9.427
EDGE SHARPNESS mm	0.025	0.025	.0.025	0.025	0.0125	0.0125	0.0125	0.025

BEVEL ANGLE: 37 DEGS

CONCENTRICITY 0.122mm

SURFACE FINISH (Ra) 2.98 microns

DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS

ROUNDNESS 0.007mm TAPER 0 degs

DRAINHOLE PRESENT ? (YES/NO): No

COMMENTS: LIGHT GREASE TO UPSTREAM

INSPECTED BY..... M Livingstone

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 6-FEB-2009

REF NO: OP90005

TEMPERATURE: 20.1 degsC

MEASURED ORIFICE BORE: 326.6505mm

PLATE DETAILS

PLATE SERIAL.	PGRN-SM-2510-B-1	PLATE O.D	647.715mm		
MANUFACTURER:	HEECO	PIPE I.D:	581.1942mm	SITE:	PETERS GREEN SM
MATERIAL CERT.No	7273	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 CERT:- 6822. NEXT CAL DUE:- 03-OCTOBER-2009

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS:-	1	2		4	5	6	7	8
FLATNESS %	0.015	0.050	0.071	0.063	0.058	0.046	0.034	0.006
E mm	25.505	25.501	25.514	25.494	25.492	25.506	25.515	25.517
	10.076	10.110	10.143	10.101	10.005	10.012	10.027	10.046
EDGE SHARPNESS mm	0.0125	0.025	0.025	0.0125	0.025	0.025	0.025	0.0125

BEVEL ANGLE 37 DEGS

CONCENTRICITY 0.036mm

SURFACE FINISH (Ra) 2.2 microns

DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS

ROUNDNESS 0.009mm TAPER: 0 degs

DRAINHOLE PRESENT ? (YES/NO): No

COMMENTS: GREASE TO UPSTREAM FACE

INSPECTED BY..... M Livingstone.

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 29-OCT-2009

REF NO: OP90022

TEMPERATURE: 20.4 degsC

MEASURED ORIFICE BORE: 326.611mm

PLATE DETAILS

PLATE SERIAL.	PGRN-SM-3520-A-2	PLATE O.D	647.839mm		
MANUFACTURER:	ANT	PIPE I.D:	582.1775mm	SITE:	PETERS GREEN SM MTC
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, 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 %	0.083	0.065	0.083	0.087	0.069	0.065	0.089	0.095
	24.718	24.735	24.738	24.717	24.682	24.665	24.660	24.691
		8.259	8.273	8.269	8.278	8.264	8.274	8.259
EDGE SHARPNESS mm	0.025	0.0125	0.0125	0.025	0.025	0.0125	SQUARE	0.0125

BEVEL ANGLE: 34 DEGS

CONCENTRICITY: 0.046mm

SURFACE FINISH (Ra): 2.53 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: 16-JUNE-2009

REF NO: OP90023

TEMPERATURE: 20.5 degsC

MEASURED ORIFICE BORE: 326.6215mm

PLATE DETAILS

PLATE SERIAL.	PGRN SM-3520-B-2	PLATE O.D	647.961mm		
MANUFACTURER:	ANT INDUSTRIES	PIPE I.D:	581.1942mm	SITE:	PETERS GREEN SM B
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, UKAS CERT:- 6822. NEXT CAL DUE:- 03-OCTOBER-2009

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS:	1	2	3	4	5		7	8
FLATNESS %	0.087	0.064	0.064	0.084	0.091	0.089	0.095	0.098
E' mm	25.276	25.282	25.275	25.273	25.259	25.273	25.272	25.261
e' mm	8.526	8.509	8.518	8.436	8.434	8.389	8.454	8.537
EDGE SHARPNESS mm	SQUARE	SQUARE	0.0125	0.0125	0.0125	SQUARE	SQUARE	SQUARE

BEVEL ANGLE: 34 DEGS

CONCENTRICITY 0.034mm

SURFACE FINISH (Ra) 0.68 microns

DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS

ROUNDNESS 0.006mm 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 PETERS GREEN 2 DURING THE PERIOD OF THE MIS-MEASUREMENT

	Original Values (total)	Corrected values (total)	% increase
Date	Volume (mscm)	Volume (mscm)	Volume (mscm)
21/6/2007	3.9659	**3.97026**	0.1100
22/6/2007	4.1707	**4.17890**	0.1966
23/6/2007	3.6413	**3.64846**	0.1966
24/6/2007	4.8694	**4.87897**	0.1966
25/6/2007	4.7433	**4.75263**	0.1966
26/6/2007	5.3235	**5.33378**	0.1931
27/6/2007	5.5337	**5.54458**	0.1966
28/6/2007	4.5255	**4.53428**	0.1939
29/6/2007	4.3676	**4.37619**	0.1966
30/6/2007	3.8797	**3.88733**	0.1966
1/7/2007	4.0676	**4.07560**	0.1966
2/7/2007	3.7085	**3.71579**	0.1966
3/7/2007	4.137	**4.14513**	0.1966
4/7/2007	4.5274	**4.53630**	0.1966
5/7/2007	3.9821	**3.98927**	0.1800
6/7/2007	3.8205	**3.82801**	0.1966
7/7/2007	3.4759	**3.48273**	0.1966
8/7/2007	3.4595	**3.46630**	0.1966
9/7/2007	3.8382	**3.84575**	0.1966
10/7/2007	3.8419	**3.84945**	0.1966
11/7/2007	4.1022	**4.11026**	0.1966
12/7/2007	3.762	**3.76940**	0.1966
13/7/2007	3.0651	**3.07113**	0.1966
14/7/2007	2.9287	**2.93446**	0.1966
15/7/2007	2.9305	**2.93626**	0.1966
16/7/2007	3.3005	**3.30699**	0.1966
17/7/2007	4.357	**4.36557**	0.1966
18/7/2007	3.4554	**3.46219**	0.1966
19/7/2007	4.0803	**4.08832**	0.1966
20/7/2007	3.6623	**3.66950**	0.1966
21/7/2007	3.5388	**3.54576**	0.1966
22/7/2007	3.4884	**3.49526**	0.1966
23/7/2007	4.0946	**4.10265**	0.1966
24/7/2007	3.2918	**3.29827**	0.1966
25/7/2007	3.8535	**3.86108**	0.1966
26/7/2007	4.0344	**4.04233**	0.1966
27/7/2007	3.5594	**3.56640**	0.1966
28/7/2007	3.5675	**3.57451**	0.1966
29/7/2007	3.6921	**3.69936**	0.1966
30/7/2007	3.889	**3.89665**	0.1966
31/7/2007	3.6579	**3.66509**	0.1966
1/8/2007	3.4175	**3.42422**	0.1966
2/8/2007	3.51649	**3.52340**	0.1966
3/8/2007	3.30611	**3.31261**	0.1966
4/8/2007	3.0835	**3.08956**	0.1966

5/8/2007	2.6561	**2.66132**	0.1966
6/8/2007	3.0205	**3.02644**	0.1966
7/8/2007	3.63	**3.63714**	0.1966
8/8/2007	3.6287	**3.63583**	0.1966
9/8/2007	3.5007	**3.50758**	0.1966
10/8/2007	3.3301	**3.33665**	0.1966
11/8/2007	3.3212	**3.32773**	0.1966
12/8/2007	3.2184	**3.22473**	0.1966
13/8/2007	3.9338	**3.94153**	0.1966
14/8/2007	3.7564	**3.76379**	0.1966
15/8/2007	3.7585	**3.76589**	0.1966
16/8/2007	4.2238	**4.23210**	0.1966
17/8/2007	4.2908	**4.29924**	0.1966
18/8/2007	3.8644	**3.87200**	0.1966
19/8/2007	3.9987	**4.00656**	0.1966
20/8/2007	4.4626	**4.47137**	0.1966
21/8/2007	4.8159	**4.82537**	0.1966
22/8/2007	5.0244	**5.03428**	0.1966
23/8/2007	5.124	**5.13407**	0.1966
24/8/2007	3.956	**3.96378**	0.1966
25/8/2007	3.4409	**3.44766**	0.1966
26/8/2007	2.8982	**2.90390**	0.1966
27/8/2007	3.3753	**3.38194**	0.1966
28/8/2007	4.1979	**4.20615**	0.1966
29/8/2007	3.7241	**3.73142**	0.1966
30/8/2007	3.9774	**3.98522**	0.1966
31/8/2007	3.6853	**3.69255**	0.1966
1/9/2007	3.2234	**3.22974**	0.1966
2/9/2007	3.1915	**3.19777**	0.1966
3/9/2007	4.19321	**4.20145**	0.1966
4/9/2007	3.719	**3.72631**	0.1966
5/9/2007	3.3741	**3.38073**	0.1966
6/9/2007	3.5754	**3.58243**	0.1966
7/9/2007	3.5419	**3.54886**	0.1966
8/9/2007	3.2551	**3.26150**	0.1966
9/9/2007	3.6836	**3.69084**	0.1966
10/9/2007	4.1908	**4.19904**	0.1966
11/9/2007	4.1965	**4.20475**	0.1966
12/9/2007	4.2247	**4.23301**	0.1966
13/9/2007	4.2649	**4.27328**	0.1966
14/9/2007	4.0183	**4.02620**	0.1966
15/9/2007	3.8793	**3.88693**	0.1966
16/9/2007	3.8849	**3.89254**	0.1966
17/9/2007	4.9748	**4.98458**	0.1966
18/9/2007	6.87	**6.88351**	0.1966
19/9/2007	5.3793	**5.38988**	0.1966
20/9/2007	4.49319	**4.50202**	0.1966
21/9/2007	4.6622	**4.67137**	0.1966
22/9/2007	3.8506	**3.85817**	0.1966
23/9/2007	3.7554	**3.76278**	0.1966
24/9/2007	4.7253	**4.73459**	0.1966
25/9/2007	5.67001	**5.68116**	0.1966
26/9/2007	7.6527	**7.66454**	0.1548
27/9/2007	8.4279	**8.43823**	0.1226
28/9/2007	7.878	**7.89017**	0.1545
29/9/2007	5.9128	**5.92436**	0.1954
30/9/2007	6.2017	**6.21389**	0.1966

1/10/2007	7.3293	**7.34048**	0.1526
2/10/2007	7.2564	**7.26744**	0.1522
3/10/2007	5.5886	**5.59955**	0.1959
4/10/2007	6.1087	**6.12026**	0.1892
5/10/2007	6.8189	**6.83018**	0.1654
6/10/2007	6.0487	**6.06054**	0.1957
7/10/2007	6.66251	**6.67345**	0.1642
8/10/2007	6.7082	**6.72127**	0.1948
9/10/2007	5.7664	**5.77774**	0.1966
10/10/2007	5.7742	**5.78555**	0.1966
11/10/2007	8.09341	**8.10356**	0.1254
12/10/2007	6.486	**6.49748**	0.1771
13/10/2007	6.2988	**6.30829**	0.1507
14/10/2007	6.3996	**6.41218**	0.1966
15/10/2007	7.6489	**7.65746**	0.1119
16/10/2007	6.9697	**6.97849**	0.1261
17/10/2007	5.9828	**5.99440**	0.1939
18/10/2007	7.5263	**7.53531**	0.1198
19/10/2007	7.696	**7.70481**	0.1144
20/10/2007	7.9723	**7.98024**	0.0996
21/10/2007	7.7675	**7.77524**	0.0997
22/10/2007	9.6456	**9.65520**	0.0996
23/10/2007	9.073	**9.08203**	0.0995
24/10/2007	9.16131	**9.17047**	0.1000
25/10/2007	8.4013	**8.40981**	0.1013
26/10/2007	7.6934	**7.70165**	0.1072
27/10/2007	5.9693	**5.98086**	0.1937
28/10/2007	5.3113	**5.32174**	0.1966
29/10/2007	6.8209	**6.82985**	0.1312
30/10/2007	6.6614	**6.67196**	0.1586
31/10/2007	7.9852	**7.99643**	0.1406
1/11/2007	7.3616	**7.37259**	0.1493
2/11/2007	5.9263	**5.93557**	0.1565
3/11/2007	5.5225	**5.53336**	0.1966
4/11/2007	6.8464	**6.85986**	0.1966
5/11/2007	8.8087	**8.81897**	0.1166
6/11/2007	8.8612	**8.87211**	0.1232
7/11/2007	8.4047	**8.41354**	0.1052
8/11/2007	7.8528	**7.86197**	0.1167
9/11/2007	10.0458	**10.05624**	0.1039
10/11/2007	7.9678	**7.97574**	0.0997
11/11/2007	8.8013	**8.81007**	0.0997
12/11/2007	10.9603	**10.97121**	0.0995
13/11/2007	9.2524	**9.26251**	0.1093
14/11/2007	9.9648	**9.97470**	0.0994
15/11/2007	11.5986	**11.61013**	0.0994
16/11/2007	10.7776	**10.78833**	0.0996
17/11/2007	10.55231	**10.56282**	0.0996
18/11/2007	9.9908	**10.00075**	0.0996
19/11/2007	8.8661	**8.87630**	0.1151
20/11/2007	8.8154	**8.82491**	0.1078
21/11/2007	8.7642	**8.77408**	0.1127
22/11/2007	8.1093	**8.11739**	0.0998
23/11/2007	10.7393	**10.75005**	0.1001
24/11/2007	9.5366	**9.54610**	0.0997
25/11/2007	9.02081	**9.03137**	0.1171
26/11/2007	8.52399	**8.53248**	0.0996

27/11/2007	7.982	**7.99058**	0.1075
28/11/2007	7.1593	**7.16882**	0.1329
29/11/2007	8.1298	**8.14096**	0.1372
30/11/2007	7.4389	**7.44944**	0.1417
1/12/2007	8.7141	**8.72357**	0.1086
2/12/2007	8.9682	**8.97716**	0.0999
3/12/2007	9.9396	**9.94949**	0.0995
4/12/2007	8.1567	**8.16575**	0.1110
5/12/2007	7.0723	**7.08152**	0.1303
6/12/2007	6.7805	**6.78981**	0.1373
7/12/2007	7.0858	**7.09618**	0.1465
8/12/2007	7.4605	**7.46793**	0.0996
9/12/2007	7.2264	**7.23381**	0.1026
10/12/2007	11.0351	**11.04617**	0.1003
11/12/2007	11.2802	**11.29143**	0.0995
12/12/2007	10.2498	**10.26000**	0.0996
13/12/2007	9.7062	**9.71830**	0.1246
14/12/2007	9.5934	**9.60295**	0.0996
15/12/2007	10.705	**10.71566**	0.0996
16/12/2007	9.8394	**9.84920**	0.0996
17/12/2007	9.9883	**9.99824**	0.0995
18/12/2007	10.439	**10.44944**	0.1000
19/12/2007	10.6888	**10.70038**	0.1083
20/12/2007	12.0954	**12.10744**	0.0995
21/12/2007	10.314	**10.32426**	0.0995
22/12/2007	10.6485	**10.65998**	0.1078
23/12/2007	10.5194	**10.52987**	0.0995
24/12/2007	9.6877	**9.69734**	0.0995
25/12/2007	9.1847	**9.19384**	0.0995
26/12/2007	9.4385	**9.44789**	0.0995
27/12/2007	7.7586	**7.76633**	0.0996
28/12/2007	8.2979	**8.30694**	0.1090
29/12/2007	9.0896	**9.09865**	0.0995
30/12/2007	8.1741	**8.18224**	0.0996
31/12/2007	9.2433	**9.25279**	0.1027
1/1/2008	7.525	**7.53327**	0.1098
2/1/2008	10.7628	**10.77351**	0.0995
3/1/2008	10.2449	**10.25509**	0.0995
4/1/2008	9.2458	**9.25500**	0.0995
5/1/2008	9.6865	**9.69614**	0.0995
6/1/2008	9.887	**9.89684**	0.0995
7/1/2008	9.9386	**9.94849**	0.0995
8/1/2008	8.1715	**8.18147**	0.1220
9/1/2008	10.2523	**10.26303**	0.1047
10/1/2008	8.9407	**8.94990**	0.1029
11/1/2008	9.1946	**9.20375**	0.0995
12/1/2008	9.4395	**9.44889**	0.0995
13/1/2008	7.6146	**7.62665**	0.1583
14/1/2008	8.8446	**8.85391**	0.1053
15/1/2008	9.2364	**9.24602**	0.1042
16/1/2008	9.3061	**9.31588**	0.1051
17/1/2008	6.8315	**6.84013**	0.1264
18/1/2008	8.5986	**8.60774**	0.1063
19/1/2008	5.9758	**5.98703**	0.1879
20/1/2008	6.256	**6.26746**	0.1831
21/1/2008	8.099	**8.10814**	0.1129
22/1/2008	9.3384	**9.34881**	0.1115

23/1/2008	8.8383	**8.84857**	0.1162
24/1/2008	9.7863	**9.79697**	0.1090
25/1/2008	10.7218	**10.73292**	0.1037
26/1/2008	10.206	**10.21701**	0.1079
27/1/2008	9.9886	**9.99854**	0.0995
28/1/2008	10.3257	**10.33636**	0.1033
29/1/2008	9.6796	**9.68963**	0.1036
30/1/2008	10.2262	**10.23670**	0.1027
31/1/2008	10.4192	**10.42957**	0.0995
1/2/2008	10.6083	**10.61886**	0.0995
2/2/2008	10.9347	**10.94558**	0.0995
3/2/2008	9.972	**9.98193**	0.0996
4/2/2008	9.1049	**9.11399**	0.0998
5/2/2008	7.74	**7.75217**	0.1572
6/2/2008	8.8008	**8.81096**	0.1154
7/2/2008	8.1239	**8.13402**	0.1246
8/2/2008	7.6016	**7.61152**	0.1305
9/2/2008	6.9302	**6.94122**	0.1590
10/2/2008	7.8181	**7.82868**	0.1354
11/2/2008	9.3366	**9.34720**	0.1136
12/2/2008	8.7288	**8.73959**	0.1237
13/2/2008	8.6068	**8.61747**	0.1240
14/2/2008	10.2777	**10.28797**	0.0999
15/2/2008	11.2782	**11.28942**	0.0995
16/2/2008	12.3076	**12.31985**	0.0995
17/2/2008	11.6104	**11.62195**	0.0995
18/2/2008	11.9925	**12.00442**	0.0994
19/2/2008	11.2036	**11.21473**	0.0994
20/2/2008	11.1241	**11.13596**	0.1066
21/2/2008	9.6427	**9.65279**	0.1046
22/2/2008	8.8698	**8.88738**	0.1982
23/2/2008	8.9572	**8.97496**	0.1983
24/2/2008	7.0647	**7.07870**	0.1982
25/2/2008	8.4418	**8.45854**	0.1983
26/2/2008	7.5546	**7.56957**	0.1981
27/2/2008	8.6725	**8.68971**	0.1985
28/2/2008	9.0604	**9.07838**	0.1985
29/2/2008	7.4653	**7.48004**	0.1974
1/3/2008	5.9346	**5.94630**	0.1971
2/3/2008	5.7381	**5.74941**	0.1971
3/3/2008	8.5995	**8.61656**	0.1984
4/3/2008	10.299	**10.31946**	0.1986
5/3/2008	8.9951	**9.01294**	0.1983
6/3/2008	8.3221	**8.33860**	0.1983
7/3/2008	7.0935	**7.10755**	0.1980
8/3/2008	7.4888	**7.50359**	0.1975
9/3/2008	7.3681	**7.38271**	0.1983
10/3/2008	8.9112	**8.92886**	0.1982
11/3/2008	8.5104	**8.52727**	0.1982
12/3/2008	9.27551	**9.29393**	0.1985
13/3/2008	7.3805	**7.39512**	0.1980
14/3/2008	6.6078	**6.62085**	0.1975
15/3/2008	6.8144	**6.82789**	0.1980
16/3/2008	9.0103	**9.02820**	0.1986
17/3/2008	8.0731	**8.08910**	0.1982
18/3/2008	9.6351	**9.65422**	0.1984
19/3/2008	9.8757	**9.89530**	0.1985

20/3/2008	9.3235	**9.34202**	0.1986
21/3/2008	8.86819	**8.88580**	0.1986
22/3/2008	10.5797	**10.60071**	0.1986
23/3/2008	11.1222	**11.14429**	0.1986
24/3/2008	11.5037	**11.52655**	0.1986
25/3/2008	10.2671	**10.28749**	0.1986
26/3/2008	8.2663	**8.28268**	0.1982
27/3/2008	6.5761	**6.58910**	0.1977
28/3/2008	8.3025	**8.31897**	0.1984
29/3/2008	8.5289	**8.54584**	0.1986
30/3/2008	7.9002	**7.91584**	0.1980
31/3/2008	7.5391	**7.55407**	0.1986
1/4/2008	7.1474	**7.16156**	0.1981
2/4/2008	7.1714	**7.18557**	0.1976
3/4/2008	6.5491	**6.56206**	0.1979
4/4/2008	9.0726	**9.09061**	0.1985
5/4/2008	7.245	**7.25936**	0.1982
6/4/2008	11.0245	**11.04640**	0.1986
7/4/2008	11.4965	**11.51933**	0.1986
8/4/2008	9.7385	**9.75784**	0.1986
9/4/2008	8.5647	**8.58170**	0.1985
10/4/2008	8.4323	**8.44901**	0.1982
11/4/2008	8.4672	**8.48401**	0.1985
12/4/2008	7.6116	**7.62670**	0.1984
13/4/2008	7.9529	**7.96868**	0.1985
14/4/2008	8.5672	**8.58420**	0.1985
15/4/2008	8.6053	**8.62238**	0.1984
16/4/2008	8.436	**8.45273**	0.1983
17/4/2008	9.3795	**9.39811**	0.1984
18/4/2008	10.1612	**10.18137**	0.1985
19/4/2008	9.3527	**9.37127**	0.1986
20/4/2008	6.1599	**6.17204**	0.1971
21/4/2008	10.332	**10.35251**	0.1985
22/4/2008	8.6537	**8.67088**	0.1985
23/4/2008	9.0119	**9.02978**	0.1984
24/4/2008	9.249	**9.26737**	0.1986
25/4/2008	7.3946	**7.40925**	0.1981
26/4/2008	6.2021	**6.21430**	0.1966
27/4/2008	6.3573	**6.36982**	0.1970
28/4/2008	8.7404	**8.75776**	0.1986
29/4/2008	10.4168	**10.43749**	0.1986
30/4/2008	11.3846	**11.40721**	0.1986
1/5/2008	9.5456	**9.56456**	0.1986
2/5/2008	5.1544	**5.16454**	0.1967
3/5/2008	3.883	**3.89063**	0.1966
4/5/2008	2.8281	**2.83366**	0.1966
5/5/2008	2.7829	**2.78837**	0.1966
6/5/2008	3.0734	**3.07944**	0.1966
7/5/2008	2.3193	**2.32386**	0.1966
8/5/2008	2.6229	**2.62806**	0.1966
9/5/2008	3.2168	**3.22312**	0.1966
10/5/2008	3.6788	**3.68603**	0.1966
11/5/2008	3.5634	**3.57041**	0.1966
12/5/2008	4.1668	**4.17499**	0.1966
13/5/2008	4.1292	**4.13732**	0.1966
14/5/2008	4.8054	**4.81485**	0.1966
15/5/2008	5.985	**5.99677**	0.1966

16/5/2008	6.9351	**6.94882**	0.1978
17/5/2008	7.3499	**7.36450**	0.1986
18/5/2008	7.03081	**7.04475**	0.1983
19/5/2008	7.9326	**7.94832**	0.1982
20/5/2008	7.3922	**7.40684**	0.1981
21/5/2008	5.5938	**5.60480**	0.1966
22/5/2008	6.1784	**6.19060**	0.1974
23/5/2008	5.0403	**5.05021**	0.1966
24/5/2008	4.3583	**4.36687**	0.1966
25/5/2008	6.003	**6.01480**	0.1966
26/5/2008	7.9084	**7.92406**	0.1980
27/5/2008	6.3954	**6.40807**	0.1981
28/5/2008	5.53979	**5.55071**	0.1972
29/5/2008	5.8992	**5.91085**	0.1975
30/5/2008	5.34721	**5.35772**	0.1966
31/5/2008	4.1755	**4.18371**	0.1966
1/6/2008	4.7838	**4.79320**	0.1966
2/6/2008	5.0952	**5.10522**	0.1966
3/6/2008	5.3865	**5.39709**	0.1966
4/6/2008	4.67561	**4.68480**	0.1966
5/6/2008	3.8086	**3.81609**	0.1966
6/6/2008	4.7836	**4.79300**	0.1966
7/6/2008	4.5644	**4.57337**	0.1966
8/6/2008	3.6741	**3.68132**	0.1966
9/6/2008	3.414	**3.42071**	0.1966
10/6/2008	3.8833	**3.89093**	0.1966
11/6/2008	4.1933	**4.20154**	0.1966
12/6/2008	4.8112	**4.82066**	0.1966
13/6/2008	4.6372	**4.64632**	0.1966
14/6/2008	4.7652	**4.77457**	0.1966
15/6/2008	4.509	**4.51786**	0.1966
16/6/2008	4.9924	**5.00222**	0.1966
17/6/2008	4.133	**4.14113**	0.1966
18/6/2008	4.3866	**4.39522**	0.1966
19/6/2008	4.3468	**4.35535**	0.1966
20/6/2008	3.9547	**3.96247**	0.1966
21/6/2008	3.8083	**3.81579**	0.1966
22/6/2008	3.7646	**3.77200**	0.1966
23/6/2008	3.7788	**3.78623**	0.1966
24/6/2008	3.89149	**3.89914**	0.1966
25/6/2008	3.9885	**3.99634**	0.1966
26/6/2008	4.3888	**4.39743**	0.1966
27/6/2008	3.7337	**3.74104**	0.1966
28/6/2008	3.4145	**3.42121**	0.1966
29/6/2008	3.6257	**3.63283**	0.1966
30/6/2008	3.3374	**3.34396**	0.1966
1/7/2008	3.1767	**3.18295**	0.1966
2/7/2008	3.8281	**3.83563**	0.1966
3/7/2008	3.4355	**3.44225**	0.1966
4/7/2008	3.8077	**3.81519**	0.1966
5/7/2008	3.1701	**3.17633**	0.1966
6/7/2008	3.5879	**3.59495**	0.1966
7/7/2008	4.1203	**4.12840**	0.1966
8/7/2008	4.1517	**4.15986**	0.1966
9/7/2008	4.515	**4.52388**	0.1966
10/7/2008	4.0363	**4.04424**	0.1966
11/7/2008	4.2368	**4.24513**	0.1966

12/7/2008	4.3672	**4.37579**	0.1966
13/7/2008	3.3956	**3.40228**	0.1966
14/7/2008	3.346	**3.35258**	0.1966
15/7/2008	3.1492	**3.15539**	0.1966
16/7/2008	3.42429	**3.43102**	0.1966
17/7/2008	3.6529	**3.66008**	0.1966
18/7/2008	3.2133	**3.21962**	0.1966
19/7/2008	3.5574	**3.56439**	0.1966
20/7/2008	3.8036	**3.81108**	0.1966
21/7/2008	3.7595	**3.76689**	0.1966
22/7/2008	3.4874	**3.49426**	0.1966
23/7/2008	3.1272	**3.13335**	0.1966
24/7/2008	3.3371	**3.34366**	0.1966
25/7/2008	2.87041	**2.87605**	0.1966
26/7/2008	2.8631	**2.86873**	0.1966
27/7/2008	2.5718	**2.57686**	0.1966
28/7/2008	2.9629	**2.96873**	0.1966
29/7/2008	3.0819	**3.08796**	0.1966
30/7/2008	2.8761	**2.88175**	0.1966
31/7/2008	2.7074	**2.71272**	0.1966
1/8/2008	3.1603	**3.16651**	0.1966
2/8/2008	2.9343	**2.94007**	0.1966
3/8/2008	2.92	**2.92574**	0.1966
4/8/2008	3.1553	**3.16150**	0.1966
5/8/2008	3.7605	**3.76789**	0.1966
6/8/2008	3.1506	**3.15679**	0.1966
7/8/2008	3.2562	**3.26260**	0.1966
8/8/2008	3.4865	**3.49335**	0.1966
9/8/2008	3.459	**3.46580**	0.1966
10/8/2008	3.5272	**3.53413**	0.1966
11/8/2008	3.7336	**3.74094**	0.1966
12/8/2008	3.7826	**3.79004**	0.1966
13/8/2008	4.3594	**4.36797**	0.1966
14/8/2008	4.05	**4.05796**	0.1966
15/8/2008	3.5796	**3.58664**	0.1966
16/8/2008	3.9317	**3.93943**	0.1966
17/8/2008	3.8181	**3.82561**	0.1966
18/8/2008	4.1342	**4.14233**	0.1966
19/8/2008	3.77299	**3.78041**	0.1966
20/8/2008	3.73161	**3.73895**	0.1966
21/8/2008	3.76949	**3.77690**	0.1966
22/8/2008	3.7566	**3.76399**	0.1966
23/8/2008	3.47011	**3.47693**	0.1966
24/8/2008	3.3943	**3.40097**	0.1966
25/8/2008	3.4028	**3.40949**	0.1966
26/8/2008	3.7189	**3.72621**	0.1966
27/8/2008	3.8127	**3.82020**	0.1966
28/8/2008	3.6785	**3.68573**	0.1966
29/8/2008	3.1229	**3.12904**	0.1966
30/8/2008	3.2736	**3.28004**	0.1966
31/8/2008	3.3548	**3.36140**	0.1966
1/9/2008	3.9538	**3.96157**	0.1966
2/9/2008	4.5683	**4.57728**	0.1966
3/9/2008	4.1777	**4.18591**	0.1966
4/9/2008	4.4673	**4.47608**	0.1966
5/9/2008	4.6182	**4.62728**	0.1966
6/9/2008	4.3128	**4.32128**	0.1966

7/9/2008	4.8062	**4.81565**	0.1966
8/9/2008	5.0203	**5.02143**	0.0243