ASSESSMENT OF ERROR DUE TO ORIFICE DIAMETER MIS-MEASUREMENT AT GREAT WILBRAHAM

A Report for

National Grid
Brick Kiln Street
HINCKLEY
Leicestershire
LE10 0NA

PROJECT NO: NGR010 **REPORT NO: 2010/231** **DATE: 16 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

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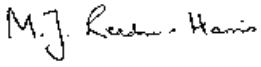
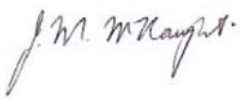
Prepared by:	Approved by:
	
Dr M J Reader-Harris	**J M McNaught**

for
Michael Valente
Managing Director

Date: 16 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 Great Wilbraham a correction factor of 1.002249 should be applied during the period of mis-measurement.

Over the period 12/10/2007 to 09/10/2008 inclusive the flow was 354.59496 mscm and the corrected flow should be 355.39076 mscm.

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 Great Wilbraham in the period of the error. The Joint Office Error Code is EA001.

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

					Value at 20 °C
Calibration Reference	Plate serial no	Declared certificate date	Orifice bore (mm)	Temperature	Orifice bore (mm)
OP4193	GWIL5135	10/03/2005	183.1265	21	183.1236
OP60017	GWIL5135	14/02/2006	183.145	21	183.1421
OP70033	GWIL4571	27/04/2007	182.9485	21	182.9456
OP80027	GWIL5135	17/06/2008	183.145	20	183.1450
OP80072	GWIL4571	29/10/2008	183.1255	20.4	183.1243
OP90043	GWIL5135	30/10/2009	183.1365	21	183.1336

Figure 1 shows the data from Table 1 for the orifice bores at 20°C. This figure shows that there is a low measurement followed by a higher measurement of orifice bore. The deduction from this graph is that a plate was mis-measured.

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

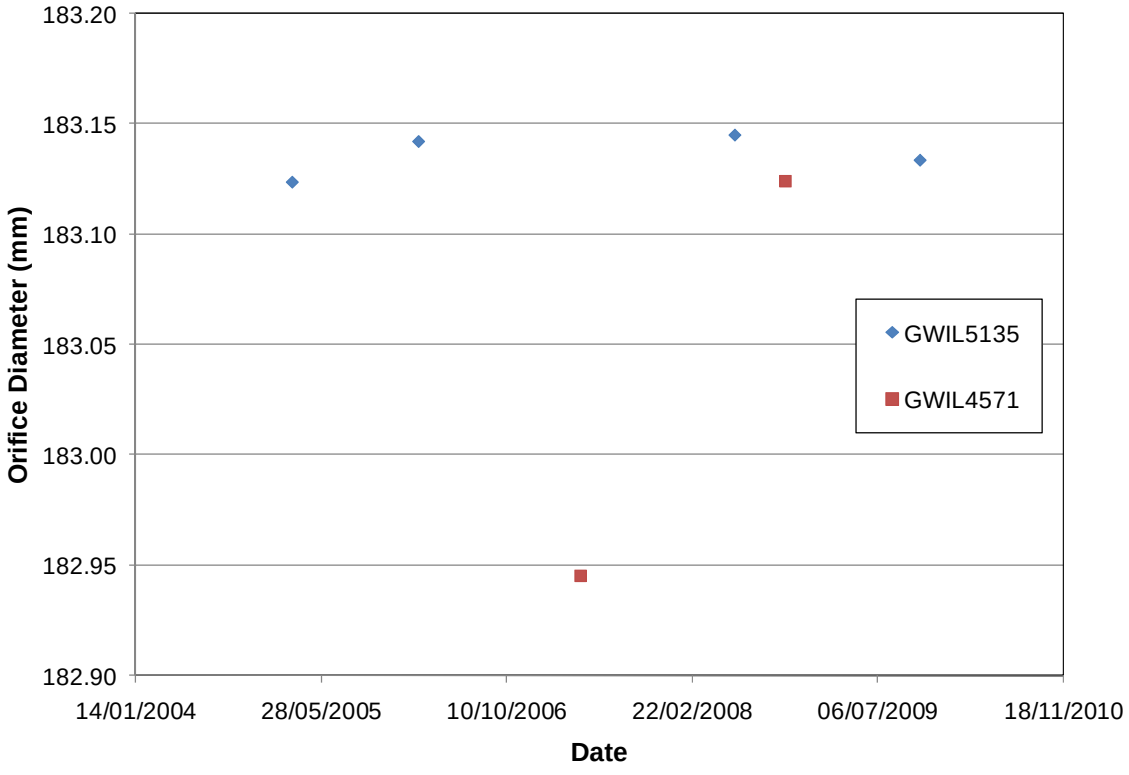


Figure 1 Orifice Diameters at 20 °C

The plates actually used in the meter tube are given in Table 2.

TABLE 2

PLATES USED IN EACH LINE AS CONFIGURED BY THE FLOW COMPUTER

Configuration	omnM0129.cfg	omnM1012.cfg	omnN1006.cfg	omnN1009.cfg
	30/01/2007 00:01	12/10/2007 23:01	06/10/2008 23:01	09/10/2008 23:01
Orifice plate bore diameter (mm)	183.145	182.9485	182.9485	183.145
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)	304.7143	304.7143	304.7143	304.7143
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	1.3512	1.3512	1.3489	1.3489
Dynamic Viscosity (Pa.s)	0.0000119	0.0000119	0.000012	0.000012
Orifice plate certificate number	OP60017	OP70033	OP70033	OP80027
Orifice plate serial number	GWIL5135	GWIL4571	GWIL4571	GWIL5135
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 effective 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 60 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 12/10/2007 to 06/10/2008 the correction can be calculated as in Table 3; throughout this calculation the meter tube diameter is 304.7143 mm, the isentropic exponent is 1.3512 and the dynamic viscosity 0.0000119 Pa s.

TABLE 3

THE CORRECTION FROM 12/10/2007 TO 06/10/2008

	d mm	β	ε	Re_D	C	$\frac{q_{m,c}}{q_{m,o}}$
Original: Δp=10 mbar	182.9456	0.600384	0.999944	1963428	0.604481	
Corrected Δp=10 mbar	183.1243	0.600971	0.999944	1967846	0.604483	1.0022501
Original Δp=500 mbar	182.9456	0.600384	0.997191	13836704	0.604106	
Corrected Δp=500 mbar	183.1243	0.600971	0.997190	13867816	0.604107	1.0022485

So $q_{m,c}/q_{m,o}$ is 1.002249.

Over the period from 06/10/2008 to 09/10/2008 the correction can be calculated as in Table 4; throughout this calculation the meter tube diameter is 304.7143 mm, the isentropic exponent is 1.3489 and the dynamic viscosity 0.000012 Pa s.

TABLE 4

THE CORRECTION FROM 06/10/2008 TO 09/10/2008

	d mm	β	ε	Re_D	C	$\frac{q_{m,c}}{q_{m,o}}$
Original: Δp=10 mbar	182.9456	0.600384	0.999944	1947076	0.604484	
Corrected Δp=10 mbar	183.1243	0.600971	0.999944	1951457	0.604486	1.0022501
Original Δp=500 mbar	182.9456	0.600384	0.997186	13721348	0.604107	
Corrected Δp=500 mbar	183.1243	0.600971	0.997185	13752201	0.604108	1.0022485

So $q_{m,c}/q_{m,o}$ is 1.002249.

4 CORRECTIONS ON A DAILY BASIS

The volume flows for each day from 12/10/2007 to 09/10/2008 are given in Table B.1 of Appendix B together with the corrected values. It has been assumed that the plates were changed at 12:30 on 12/10/2007 and 12:00 on 09/10/2008; therefore 62.8% of the flow for 12/10/2007 has to be corrected and 35.3% of the flow for 09/10/2008 has to be corrected based on the proportion of flow before and after the time of the plate change. Summing the data gives the figures in Table 5.

TABLE 5

THE FLOW OVER THE PERIOD 12/10/2007 TO 09/10/2008 INCLUSIVE

Flow (mscm)	354.59496
Correction (mscm)	0.79580
Corrected flow (mscm)	355.39076
% change	0.2244

5 CONCLUSIONS

A correction factor of 1.002249 should be applied during the period of mis-measurement.

APPENDIX A
ORIFICE PLATE CALIBRATION CERTIFICATES

TRANSCO ORIFICE PLATE CALIBRATION

DATE: ***10-03-05***

REF NO: ***OP4193***

TEMPERATURE: ***21 degsC***

MEASURED ORIFICE BORE: ***183.1265mm***

PLATE DETAILS

PLATE SERIAL.	GWIL5135	PLATE O.D	332.269mm		
MANUFACTURER:	DANIEL	PIPE I.D:	304.673mm	SITE:	GREAT WILBRAHAM
MATERIAL CERT.No.	Y5734	DESIGN BORE	183.105mm	FLOW:	3456000 M^3/day

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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 %	0.140	0.197	0.113	0.146	0.167	0.118	0.195	
'E' mm	5.926	5.938	5.939	5.928	5.895	5.928	5.932	5.907
'e' mm	4.254	4.173	4.198	4.234	4.217	4.176	4.300	4.312
EDGE SHARPNESS mm	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025

BEVEL ANGLE 37 DEGS

CONCENTRICITY 0.115mm

SURFACE FINISH (Ra) 1.0 microns

DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS

ROUNDNESS : 0.031mm TAPER: 0 degs

COMMENTS:

INSPECTED BY ..... G.WARDLE

VERIFIED BY... ..... P.KENNERSON

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 14-02-06

REF NO: OP60017

TEMPERATURE: 21 degsC

MEASURED ORIFICE BORE: 183.145mm

PLATE DETAILS

PLATE SERIAL.	GWIL5135	PLATE O.D	332.014mm		
MANUFACTURER:	DANIEL	PIPE I.D:	mm	SITE:	GREAT WILBRAHAM
MATERIAL CERT.No	T7259	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:- 14/10/06

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS:-	1	2	3	4		6	7	
FLATNESS %	0.015	0.128	0.166	0.023	0.090	0.015	0.074	0.064
'E' mm	6.430	6.444	6.439	6.426	6.419	6.391	6.397	
'e' mm	4.109	4.028	4.005	4.126	4.129	3.974	3.969	
EDGE SHARPNESS mm	0.0125	SQ	SQ	SQ	SQ	0.0125	SQ	
BEVEL ANGLE	36 DEGS							
CONCENTRICITY	0.074mm							
SURFACE FINISH (Ra)	0.7 microns							

DOWNSTREAM FACE/EDGE VISUAL INSPECTION

ROUNDNESS 0.009mm TAPER 0 degs

COMMENTS:

INSPECTED BY P.KENNERSON

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 27-04-07

REF NO: OP70033

TEMPERATURE: 21 degsC

MEASURED ORIFICE BORE: 182.9485mm

PLATE DETAILS

PLATE SERIAL.	GWIL4571	PLATE O.D	331.984mm		
MANUFACTURER:	DANIEL	PIPE I.D:	304.673mm	SITE:	GREAT WILBRAHAM
MATERIAL CERT.No	Y5734	DESIGN BORE:	183.105mm	FLOW:	3.456000 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 %	0.137	0.193	0.107	0.137	0.151	0.089	0.184	0.122
'E' mm	5.971	5.920	5.915	5.996	5.959	5.889	5.900	5.956
'e' mm	4.281	4.157	4.207	4.261	4.255	4.159	4.289	4.361
EDGE SHARPNESS mm	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125

BEVEL ANGLE: 37 DEGS

CONCENTRICITY 0.086mm

SURFACE FINISH (Ra) 1.5 microns

DOWNSTREAM FACE/EDGE VISUAL INSPECTION : PASS

ROUNDNESS 0.132mm TAPER: 0 degs

COMMENTS:

INSPECTED BY P.KENNERSON

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 17-JUNE-2008

REF NO: OP80027

TEMPERATURE: 20 degsC

MEASURED ORIFICE BORE: 183.145mm

PLATE DETAILS

PLATE SERIAL.	GWIL5135	PLATE O.D	332.109mm		
MANUFACTURER:	DANIEL	PIPE I.D:	304.7143mm	SITE:	GREAT WILBRAHAM
MATERIAL CERT.No.	T7259	DESIGN BORE:	183.105mm	FLOW:	3456000 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	6		8
FLATNESS %	0.013	0.075	0.062	0.157	0.031			0.155
	6.429	6.435	6.407	6.361	6.408	6.416	6.442	6.448
mm	4.065	4.142	4.052	3.930			4.074	4.013
EDGE SHARPNESS mm	SQUARE	SQUARE	SQUARE	SQUARE	SQUARE	SQUARE	SQUARE	SQUARE

BEVEL ANGLE: 36 DEGS

CONCENTRICITY 0.024mm

SURFACE FINISH (Ra) 0.6 microns

DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS

ROUNDNESS 0.006mm TAPER: 0 degs

DRAINHOLE PRESENT ? (YES/NO) No

COMMENTS: CLEAN PLATE

INSPECTED BY.....M Livingstone

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 29-OCT-2008

REF NO: OP80072

TEMPERATURE: 20.4 degsC

MEASURED ORIFICE BORE: 183.1255mm

PLATE DETAILS

PLATE SERIAL.	GWIL 4571	PLATE O.D	332.239mm		
MANUFACTURER:	DANIEL	PIPE I.D:	304.7143mm	SITE:	GREAT WILBRAHAM
MATERIAL CERT.No	Y5734	DESIGN BORE:	183.105mm	FLOW:	3.456000 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	6	7	8
FLATNESS %	0.113	0.177	0.106	0.131	0.141	0.104	0.196	0.110
E' mm	5.894	5.937	5.934	5.916	5.879	5.905	5.917	5.885
e' mm	4.239	4.166	4.215	4.217	4.201	4.165	4.322	4.318
EDGE SHARPNESS mm	0.025	0.025	0.025	0.025	0.025	0.025	0.0125	0.0125

BEVEL ANGLE: 37 DEGS

CONCENTRICITY 0.068mm

SURFACE FINISH (Ra) 0.9 microns

DOWNSTREAM FACE/EDGE VISUAL INSPECTION PASS

ROUNDNESS : 0.041mm TAPER: 0 degs

DRAINHOLE PRESENT ? (YES/NO) No

COMMENTS: LIGHT BROWN DUSTING TO U-STREAM

INSPECTED BY..... M Livingston

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 30-OCT-2009

REF NO: OP90043

TEMPERATURE: 20.6 degsC

MEASURED ORIFICE BORE: 183.1365mm

PLATE DETAILS

PLATE SERIAL.	GWIL5135	PLATE O.D	332.116mm		
MANUFACTURER:	DANIEL	PIPE I.D:	304.7143mm	SITE:	GREAT WILBRAHAM
MATERIAL CERT.No.	T7259	DESIGN BORE	183.105mm	FLOW:	3456000 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		4	5		7	8
FLATNESS %	0.005	0.079	0.057	0.087	0.013	0.058	0.106	0.093
E' mm	6.424	6.430	6.420	6.414	6.411	6.430	6.420	6.428
	4.052	4.051	4.060	4.057	4.049	4.062	4.071	4.047
EDGE SHARPNESS mm	SQUARE	SQUARE	SQUARE	SQUARE	SQUARE	0.0125	SQUARE	SQUARE

BEVEL ANGLE: 36 DEGS

CONCENTRICITY 0.023mm

SURFACE FINISH (Ra) 0.6 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

APPENDIX B
CORRECTED DAILY VOLUME FLOWS

TABLE B.1

FLOWS AT GREAT WILBRAHAM DURING THE PERIOD OF THE MIS-MEASUREMENT

	Original Values (total)	Corrected values (total)	% increase
Date	Volume (mscm)	Volume (mscm)	Volume (mscm)
12-Oct-07	0.62620	**0.62708**	0.1413
13-Oct-07	0.56450	**0.56577**	0.2249
14-Oct-07	0.64990	**0.65136**	0.2249
15-Oct-07	0.74170	**0.74337**	0.2249
16-Oct-07	0.70700	**0.70859**	0.2249
17-Oct-07	0.83720	**0.83908**	0.2249
18-Oct-07	1.02010	**1.02239**	0.2249
19-Oct-07	1.08770	**1.09015**	0.2249
20-Oct-07	1.02600	**1.02831**	0.2249
21-Oct-07	1.02720	**1.02951**	0.2249
22-Oct-07	1.17720	**1.17985**	0.2249
23-Oct-07	1.20520	**1.20791**	0.2249
24-Oct-07	1.18970	**1.19238**	0.2249
25-Oct-07	1.09910	**1.10157**	0.2249
26-Oct-07	1.05720	**1.05958**	0.2249
27-Oct-07	0.95270	**0.95484**	0.2249
28-Oct-07	0.81380	**0.81563**	0.2249
29-Oct-07	1.00080	**1.00305**	0.2249
30-Oct-07	1.05270	**1.05507**	0.2249
31-Oct-07	1.00890	**1.01117**	0.2249
01-Nov-07	0.95010	**0.95224**	0.2249
02-Nov-07	0.86330	**0.86524**	0.2249
03-Nov-07	0.90850	**0.91054**	0.2249
04-Nov-07	1.11320	**1.11570**	0.2249
05-Nov-07	1.34490	**1.34792**	0.2249
06-Nov-07	1.28050	**1.28338**	0.2249
07-Nov-07	1.17470	**1.17734**	0.2249
08-Nov-07	1.21370	**1.21643**	0.2249
09-Nov-07	1.40900	**1.41217**	0.2249
10-Nov-07	1.12060	**1.12312**	0.2249
11-Nov-07	1.21330	**1.21603**	0.2249
12-Nov-07	1.55560	**1.55910**	0.2249
13-Nov-07	1.48840	**1.49175**	0.2249
14-Nov-07	1.49190	**1.49526**	0.2249
15-Nov-07	1.64150	**1.64519**	0.2249
16-Nov-07	1.69050	**1.69430**	0.2249
17-Nov-07	1.53450	**1.53795**	0.2249
18-Nov-07	1.56770	**1.57123**	0.2249
19-Nov-07	1.48880	**1.49215**	0.2249

20-Nov-07	1.36390	**1.36697**	0.2249
21-Nov-07	1.21530	**1.21803**	0.2249
22-Nov-07	1.30760	**1.31054**	0.2249
23-Nov-07	1.65840	**1.66213**	0.2249
24-Nov-07	1.69350	**1.69731**	0.2249
25-Nov-07	1.42280	**1.42600**	0.2249
26-Nov-07	1.54800	**1.55148**	0.2249
27-Nov-07	1.40100	**1.40415**	0.2249
28-Nov-07	1.34380	**1.34682**	0.2249
29-Nov-07	1.37630	**1.37940**	0.2249
30-Nov-07	1.23010	**1.23287**	0.2249
01-Dec-07	1.32050	**1.32347**	0.2249
02-Dec-07	1.33400	**1.33700**	0.2249
03-Dec-07	1.46390	**1.46719**	0.2249
04-Dec-07	1.30200	**1.30493**	0.2249
05-Dec-07	1.15240	**1.15499**	0.2249
06-Dec-07	1.13100	**1.13354**	0.2249
07-Dec-07	1.33000	**1.33299**	0.2249
08-Dec-07	1.43090	**1.43412**	0.2249
09-Dec-07	1.41090	**1.41407**	0.2249
10-Dec-07	1.68050	**1.68428**	0.2249
11-Dec-07	1.82430	**1.82840**	0.2249
12-Dec-07	1.91900	**1.92332**	0.2249
13-Dec-07	1.92870	**1.93304**	0.2249
14-Dec-07	1.77650	**1.78050**	0.2249
15-Dec-07	1.73621	**1.74011**	0.2249
16-Dec-07	1.79250	**1.79653**	0.2249
17-Dec-07	1.93700	**1.94136**	0.2249
18-Dec-07	1.84350	**1.84765**	0.2249
19-Dec-07	1.90740	**1.91169**	0.2249
20-Dec-07	1.99989	**2.00439**	0.2249
21-Dec-07	1.84980	**1.85396**	0.2249
22-Dec-07	1.69010	**1.69390**	0.2249
23-Dec-07	1.74820	**1.75213**	0.2249
24-Dec-07	1.47571	**1.47903**	0.2249
25-Dec-07	1.33680	**1.33981**	0.2249
26-Dec-07	1.43350	**1.43672**	0.2249
27-Dec-07	1.27660	**1.27947**	0.2249
28-Dec-07	1.26790	**1.27075**	0.2249
29-Dec-07	1.35710	**1.36015**	0.2249
30-Dec-07	1.34190	**1.34492**	0.2249
31-Dec-07	1.38570	**1.38882**	0.2249
01-Jan-08	1.33610	**1.33910**	0.2249
02-Jan-08	1.74920	**1.75313**	0.2249
03-Jan-08	1.90450	**1.90878**	0.2249
04-Jan-08	1.64230	**1.64599**	0.2249
05-Jan-08	1.50740	**1.51079**	0.2249
06-Jan-08	1.55920	**1.56271**	0.2249

07-Jan-08	1.66180	**1.66554**	0.2249
08-Jan-08	1.56510	**1.56862**	0.2249
09-Jan-08	1.62220	**1.62585**	0.2249
10-Jan-08	1.46820	**1.47150**	0.2249
11-Jan-08	1.49220	**1.49556**	0.2249
12-Jan-08	1.51960	**1.52302**	0.2249
13-Jan-08	1.36100	**1.36406**	0.2249
14-Jan-08	1.44070	**1.44394**	0.2249
15-Jan-08	1.38870	**1.39182**	0.2249
16-Jan-08	1.54400	**1.54747**	0.2249
17-Jan-08	1.61040	**1.61402**	0.2249
18-Jan-08	1.38420	**1.38731**	0.2249
19-Jan-08	1.11960	**1.12212**	0.2249
20-Jan-08	1.04280	**1.04515**	0.2249
21-Jan-08	1.29660	**1.29952**	0.2249
22-Jan-08	1.55890	**1.56241**	0.2249
23-Jan-08	1.32150	**1.32447**	0.2249
24-Jan-08	1.42000	**1.42319**	0.2249
25-Jan-08	1.51800	**1.52141**	0.2249
26-Jan-08	1.38110	**1.38421**	0.2249
27-Jan-08	1.37000	**1.37308**	0.2249
28-Jan-08	1.64910	**1.65281**	0.2249
29-Jan-08	1.50930	**1.51269**	0.2249
30-Jan-08	1.62370	**1.62735**	0.2249
31-Jan-08	1.72580	**1.72968**	0.2249
01-Feb-08	1.79720	**1.80124**	0.2249
02-Feb-08	1.73260	**1.73650**	0.2249
03-Feb-08	1.64910	**1.65281**	0.2249
04-Feb-08	1.57840	**1.58195**	0.2249
05-Feb-08	1.37940	**1.38250**	0.2249
06-Feb-08	1.47340	**1.47671**	0.2249
07-Feb-08	1.42990	**1.43312**	0.2249
08-Feb-08	1.39280	**1.39593**	0.2249
09-Feb-08	1.32750	**1.33049**	0.2249
10-Feb-08	1.38640	**1.38952**	0.2249
11-Feb-08	1.55860	**1.56211**	0.2249
12-Feb-08	1.58530	**1.58887**	0.2249
13-Feb-08	1.79089	**1.79492**	0.2249
14-Feb-08	1.75600	**1.75995**	0.2249
15-Feb-08	1.73650	**1.74041**	0.2249
16-Feb-08	1.81190	**1.81597**	0.2249
17-Feb-08	1.80880	**1.81287**	0.2249
18-Feb-08	1.93040	**1.93474**	0.2249
19-Feb-08	2.01750	**2.02204**	0.2249
20-Feb-08	1.89110	**1.89535**	0.2249
21-Feb-08	1.59840	**1.60199**	0.2249
22-Feb-08	1.39290	**1.39603**	0.2249
23-Feb-08	1.27840	**1.28128**	0.2249

24-Feb-08	1.26050	**1.26333**	0.2249
25-Feb-08	1.44380	**1.44705**	0.2249
26-Feb-08	1.28050	**1.28338**	0.2249
27-Feb-08	1.36560	**1.36867**	0.2249
28-Feb-08	1.41660	**1.41979**	0.2249
29-Feb-08	1.53980	**1.54326**	0.2249
01-Mar-08	1.26000	**1.26283**	0.2249
02-Mar-08	1.18250	**1.18516**	0.2249
03-Mar-08	1.52400	**1.52743**	0.2249
04-Mar-08	1.71430	**1.71816**	0.2249
05-Mar-08	1.58600	**1.58957**	0.2249
06-Mar-08	1.30860	**1.31154**	0.2249
07-Mar-08	1.27020	**1.27306**	0.2249
08-Mar-08	1.27400	**1.27687**	0.2249
09-Mar-08	1.27360	**1.27646**	0.2249
10-Mar-08	1.54950	**1.55298**	0.2249
11-Mar-08	1.41070	**1.41387**	0.2249
12-Mar-08	1.47790	**1.48122**	0.2249
13-Mar-08	1.42480	**1.42800**	0.2249
14-Mar-08	1.15930	**1.16191**	0.2249
15-Mar-08	1.02050	**1.02280**	0.2249
16-Mar-08	1.34950	**1.35254**	0.2249
17-Mar-08	1.54820	**1.55168**	0.2249
18-Mar-08	1.67460	**1.67837**	0.2249
19-Mar-08	1.62580	**1.62946**	0.2249
20-Mar-08	1.60730	**1.61091**	0.2249
21-Mar-08	1.54330	**1.54677**	0.2249
22-Mar-08	1.70100	**1.70483**	0.2249
23-Mar-08	1.75380	**1.75774**	0.2249
24-Mar-08	1.72280	**1.72667**	0.2249
25-Mar-08	1.64210	**1.64579**	0.2249
26-Mar-08	1.49360	**1.49696**	0.2249
27-Mar-08	1.32670	**1.32968**	0.2249
28-Mar-08	1.48840	**1.49175**	0.2249
29-Mar-08	1.23320	**1.23597**	0.2249
30-Mar-08	1.02590	**1.02821**	0.2249
31-Mar-08	1.11560	**1.11811**	0.2249
01-Apr-08	1.07500	**1.07742**	0.2249
02-Apr-08	1.02250	**1.02480**	0.2249
03-Apr-08	0.95820	**0.96035**	0.2249
04-Apr-08	0.94650	**0.94863**	0.2249
05-Apr-08	1.18030	**1.18295**	0.2249
06-Apr-08	1.46550	**1.46880**	0.2249
07-Apr-08	1.54960	**1.55309**	0.2249
08-Apr-08	1.40950	**1.41267**	0.2249
09-Apr-08	1.27100	**1.27386**	0.2249
10-Apr-08	1.17460	**1.17724**	0.2249
11-Apr-08	1.21650	**1.21924**	0.2249

12-Apr-08	1.12520	**1.12773**	0.2249
13-Apr-08	1.14040	**1.14296**	0.2249
14-Apr-08	1.28190	**1.28478**	0.2249
15-Apr-08	1.26190	**1.26474**	0.2249
16-Apr-08	1.23500	**1.23778**	0.2249
17-Apr-08	1.26280	**1.26564**	0.2249
18-Apr-08	1.25649	**1.25932**	0.2249
19-Apr-08	1.23830	**1.24108**	0.2249
20-Apr-08	1.09790	**1.10037**	0.2249
21-Apr-08	0.98020	**0.98240**	0.2249
22-Apr-08	0.86200	**0.86394**	0.2249
23-Apr-08	0.93520	**0.93730**	0.2249
24-Apr-08	0.97780	**0.98000**	0.2249
25-Apr-08	0.83650	**0.83838**	0.2249
26-Apr-08	0.58440	**0.58571**	0.2249
27-Apr-08	0.60239	**0.60374**	0.2249
28-Apr-08	0.79790	**0.79969**	0.2249
29-Apr-08	0.93900	**0.94111**	0.2249
30-Apr-08	1.10130	**1.10378**	0.2249
01-May-08	0.94230	**0.94442**	0.2249
02-May-08	0.81870	**0.82054**	0.2249
03-May-08	0.65929	**0.66077**	0.2249
04-May-08	0.54021	**0.54142**	0.2249
05-May-08	0.53660	**0.53781**	0.2249
06-May-08	0.52380	**0.52498**	0.2249
07-May-08	0.45670	**0.45773**	0.2249
08-May-08	0.43170	**0.43267**	0.2249
09-May-08	0.40140	**0.40230**	0.2249
10-May-08	0.34170	**0.34247**	0.2249
11-May-08	0.33290	**0.33365**	0.2249
12-May-08	0.39740	**0.39829**	0.2249
13-May-08	0.42820	**0.42916**	0.2249
14-May-08	0.45260	**0.45362**	0.2249
15-May-08	0.55250	**0.55374**	0.2249
16-May-08	0.69670	**0.69827**	0.2249
17-May-08	0.69569	**0.69725**	0.2249
18-May-08	0.66080	**0.66229**	0.2249
19-May-08	0.80389	**0.80570**	0.2249
20-May-08	0.75980	**0.76151**	0.2249
21-May-08	0.64890	**0.65036**	0.2249
22-May-08	0.58500	**0.58632**	0.2249
23-May-08	0.48140	**0.48248**	0.2249
24-May-08	0.41090	**0.41182**	0.2249
25-May-08	0.56660	**0.56787**	0.2249
26-May-08	0.71700	**0.71861**	0.2249
27-May-08	0.60150	**0.60285**	0.2249
28-May-08	0.52680	**0.52798**	0.2249
29-May-08	0.51100	**0.51215**	0.2249

30-May-08	0.49470	**0.49581**	0.2249
31-May-08	0.39880	**0.39970**	0.2249
01-Jun-08	0.50660	**0.50774**	0.2249
02-Jun-08	0.50640	**0.50754**	0.2249
03-Jun-08	0.61020	**0.61157**	0.2249
04-Jun-08	0.51200	**0.51315**	0.2249
05-Jun-08	0.45840	**0.45943**	0.2249
06-Jun-08	0.46390	**0.46494**	0.2249
07-Jun-08	0.48290	**0.48399**	0.2249
08-Jun-08	0.40460	**0.40551**	0.2249
09-Jun-08	0.39610	**0.39699**	0.2249
10-Jun-08	0.40360	**0.40451**	0.2249
11-Jun-08	0.43240	**0.43337**	0.2249
12-Jun-08	0.52180	**0.52297**	0.2249
13-Jun-08	0.51710	**0.51826**	0.2249
14-Jun-08	0.44440	**0.44540**	0.2249
15-Jun-08	0.44870	**0.44971**	0.2249
16-Jun-08	0.49580	**0.49692**	0.2249
17-Jun-08	0.47270	**0.47376**	0.2249
18-Jun-08	0.50400	**0.50513**	0.2249
19-Jun-08	0.47610	**0.47717**	0.2249
20-Jun-08	0.43460	**0.43558**	0.2249
21-Jun-08	0.43180	**0.43277**	0.2249
22-Jun-08	0.40010	**0.40100**	0.2249
23-Jun-08	0.46000	**0.46103**	0.2249
24-Jun-08	0.43970	**0.44069**	0.2249
25-Jun-08	0.41990	**0.42084**	0.2249
26-Jun-08	0.41090	**0.41182**	0.2249
27-Jun-08	0.40070	**0.40160**	0.2249
28-Jun-08	0.33840	**0.33916**	0.2249
29-Jun-08	0.36630	**0.36712**	0.2249
30-Jun-08	0.41820	**0.41914**	0.2249
01-Jul-08	0.38190	**0.38276**	0.2249
02-Jul-08	0.40330	**0.40421**	0.2249
03-Jul-08	0.41320	**0.41413**	0.2249
04-Jul-08	0.38230	**0.38316**	0.2249
05-Jul-08	0.35560	**0.35640**	0.2249
06-Jul-08	0.38460	**0.38546**	0.2249
07-Jul-08	0.45510	**0.45612**	0.2249
08-Jul-08	0.45220	**0.45322**	0.2249
09-Jul-08	0.49220	**0.49331**	0.2249
10-Jul-08	0.43600	**0.43698**	0.2249
11-Jul-08	0.42710	**0.42806**	0.2249
12-Jul-08	0.44070	**0.44169**	0.2249
13-Jul-08	0.41000	**0.41092**	0.2249
14-Jul-08	0.42990	**0.43087**	0.2249
15-Jul-08	0.39700	**0.39789**	0.2249
16-Jul-08	0.42220	**0.42315**	0.2249

17-Jul-08	0.46280	**0.46384**	0.2249
18-Jul-08	0.42190	**0.42285**	0.2249
19-Jul-08	0.39040	**0.39128**	0.2249
20-Jul-08	0.41970	**0.42064**	0.2249
21-Jul-08	0.44300	**0.44400**	0.2249
22-Jul-08	0.41100	**0.41192**	0.2249
23-Jul-08	0.36280	**0.36362**	0.2249
24-Jul-08	0.35090	**0.35169**	0.2249
25-Jul-08	0.32470	**0.32543**	0.2249
26-Jul-08	0.27500	**0.27562**	0.2249
27-Jul-08	0.26420	**0.26479**	0.2249
28-Jul-08	0.31720	**0.31791**	0.2249
29-Jul-08	0.33260	**0.33335**	0.2249
30-Jul-08	0.33020	**0.33094**	0.2249
31-Jul-08	0.32150	**0.32222**	0.2249
01-Aug-08	0.35290	**0.35369**	0.2249
02-Aug-08	0.31730	**0.31801**	0.2249
03-Aug-08	0.33060	**0.33134**	0.2249
04-Aug-08	0.38770	**0.38857**	0.2249
05-Aug-08	0.40640	**0.40731**	0.2249
06-Aug-08	0.37230	**0.37314**	0.2249
07-Aug-08	0.38110	**0.38196**	0.2249
08-Aug-08	0.39730	**0.39819**	0.2249
09-Aug-08	0.36590	**0.36672**	0.2249
10-Aug-08	0.33840	**0.33916**	0.2249
11-Aug-08	0.38760	**0.38847**	0.2249
12-Aug-08	0.39660	**0.39749**	0.2249
13-Aug-08	0.41390	**0.41483**	0.2249
14-Aug-08	0.41830	**0.41924**	0.2249
15-Aug-08	0.38130	**0.38216**	0.2249
16-Aug-08	0.33850	**0.33926**	0.2249
17-Aug-08	0.34250	**0.34327**	0.2249
18-Aug-08	0.40410	**0.40501**	0.2249
19-Aug-08	0.40870	**0.40962**	0.2249
20-Aug-08	0.40580	**0.40671**	0.2249
21-Aug-08	0.38810	**0.38897**	0.2249
22-Aug-08	0.36630	**0.36712**	0.2249
23-Aug-08	0.30200	**0.30268**	0.2249
24-Aug-08	0.32420	**0.32493**	0.2249
25-Aug-08	0.34860	**0.34938**	0.2249
26-Aug-08	0.39040	**0.39128**	0.2249
27-Aug-08	0.39760	**0.39849**	0.2249
28-Aug-08	0.37360	**0.37444**	0.2249
29-Aug-08	0.33080	**0.33154**	0.2249
30-Aug-08	0.30970	**0.31040**	0.2249
31-Aug-08	0.34020	**0.34097**	0.2249
01-Sep-08	0.41340	**0.41433**	0.2249
02-Sep-08	0.44350	**0.44450**	0.2249

03-Sep-08	0.46610	**0.46715**	0.2249
04-Sep-08	0.48780	**0.48890**	0.2249
05-Sep-08	0.48780	**0.48890**	0.2249
06-Sep-08	0.43080	**0.43177**	0.2249
07-Sep-08	0.44800	**0.44901**	0.2249
08-Sep-08	0.46850	**0.46955**	0.2249
09-Sep-08	0.49730	**0.49842**	0.2249
10-Sep-08	0.45730	**0.45833**	0.2249
11-Sep-08	0.46800	**0.46905**	0.2249
12-Sep-08	0.53500	**0.53620**	0.2249
13-Sep-08	0.46400	**0.46504**	0.2249
14-Sep-08	0.45020	**0.45121**	0.2249
15-Sep-08	0.52650	**0.52768**	0.2249
16-Sep-08	0.57170	**0.57299**	0.2249
17-Sep-08	0.59020	**0.59153**	0.2249
18-Sep-08	0.57420	**0.57549**	0.2249
19-Sep-08	0.52530	**0.52648**	0.2249
20-Sep-08	0.48460	**0.48569**	0.2249
21-Sep-08	0.50610	**0.50724**	0.2249
22-Sep-08	0.58030	**0.58161**	0.2249
23-Sep-08	0.61560	**0.61698**	0.2249
24-Sep-08	0.58900	**0.59032**	0.2249
25-Sep-08	0.52790	**0.52909**	0.2249
26-Sep-08	0.54100	**0.54222**	0.2249
27-Sep-08	0.51220	**0.51335**	0.2249
28-Sep-08	0.52380	**0.52498**	0.2249
29-Sep-08	0.62270	**0.62410**	0.2249
30-Sep-08	0.66580	**0.66730**	0.2249
01-Oct-08	0.72050	**0.72212**	0.2249
02-Oct-08	0.87320	**0.87516**	0.2249
03-Oct-08	1.03240	**1.03472**	0.2249
04-Oct-08	0.96650	**0.96867**	0.2249
05-Oct-08	0.86230	**0.86424**	0.2249
06-Oct-08	0.98020	**0.98240**	0.2249
07-Oct-08	0.76340	**0.76512**	0.2249
08-Oct-08	0.82680	**0.82866**	0.2249
09-Oct-08	0.79390	**0.79453**	0.0793