ASSESSMENT OF ERROR DUE TO ORIFICE DIAMETER MIS-MEASUREMENT AT TUR LANGTON

A Report for

National Grid
Brick Kiln Street
HINCKLEY
Leicestershire
LE10 0NA

PROJECT NO: NGR010 **REPORT NO: 2010/236** **DATE: 28 JUNE 2010**

This report is issued as part of the contract under which the work has been carried out for the client.

NOTES

1 **This report may be published in full by the client unless it includes information supplied in confidence by TUV NEL Ltd or any third party. Such information, if included within the report, shall be identified as confidential by TUV NEL Ltd.**

2a **The prior written consent of TUV NEL Ltd shall be obtained by the client before publication by them of any extract from, or abridgement of, this report.**

2b **The prior written consent of TUV NEL Ltd shall be obtained by the client before publication:**

- **Where such publication is made in connection with any public enquiry, legal proceedings or arbitration.**
- **Where such publication is made in connection with any company prospectus or similar document.**
- **Where the client has notice that TUV NEL Ltd is seeking or intends to seek patent or like protection for any intellectual property produced in the course of rendering the services.**

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 Tur Langton

A Report for

National Grid
Brick Kiln Street
HINCKLEY
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: 28 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 Tur Langton a correction factor of 1.002389 should be applied during the period of mis-measurement.

Over the period 14/09/2007 to 20/08/2008 inclusive the flow was 867.61842 mscm and the corrected flow should be 869.69071 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 Tur Langton in the period of the error. The Joint Office Error Code is EM004.

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)
OP4221	302-1	30/08/2005	289.6550	21	289.6504
OP50205	302	13/09/2006	289.6620	21	289.6574
OP60166	302-1	01/12/2006	289.3815	21	289.3769
OP80052	302	15/08/2008	289.6690	20.7	289.6658
OP80060	302-1	29/09/2008	289.6655	20	289.6655
OP90033	302	14/08/2009	289.6685	20.4	289.6666

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.

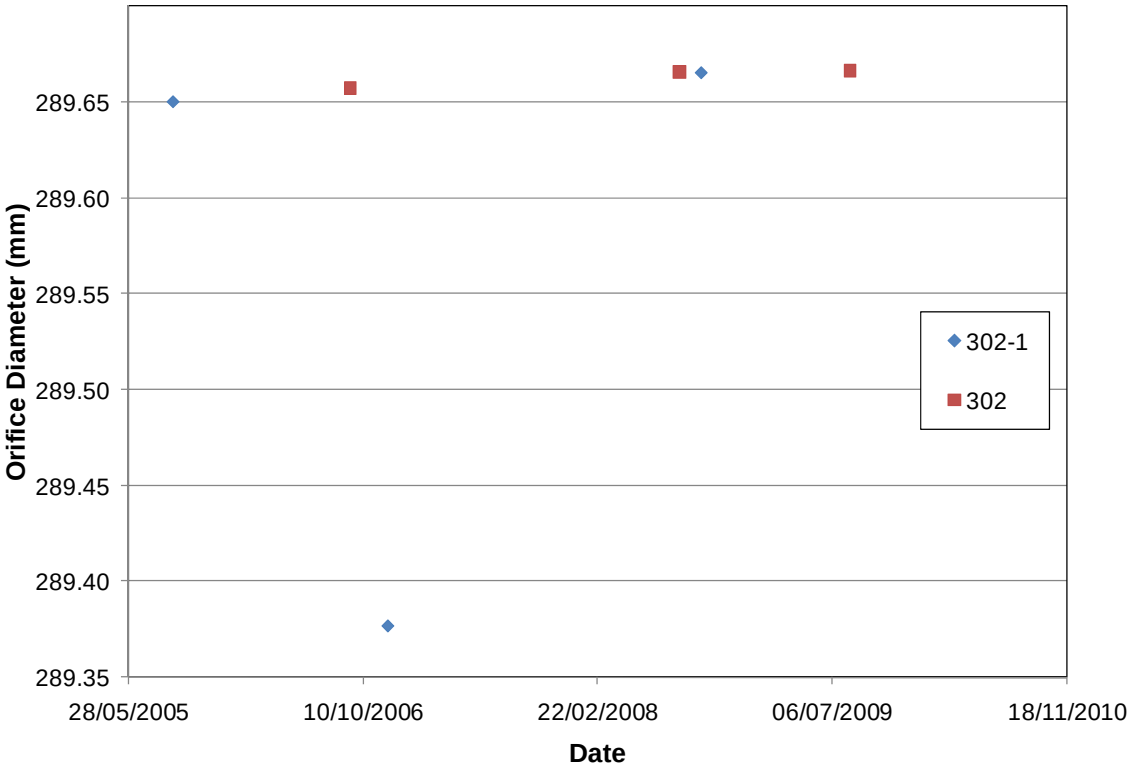

Figure 1 Orifice Diameters at 20 °C

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

TABLE 2

PLATES USED IN EACH LINE AS CONFIGURED BY THE FLOW COMPUTER

Configuration	omnM0912.cfg	omnM0914.cfg	omnN0820.cfg
	12/09/2007 23:01	14/09/2007 23:01	20/08/2008 23:01
Orifice plate bore diameter (mm)	289.662	289.3815	289.669
Expansion coefficient of the plate (/°C)	0.000016	0.000016	0.000016
Orifice plate calibration temperature	21	21	20
Meter tube diameter (mm)	432.5747	432.5747	432.5747
Expansion coefficient of the meter tube (/°C)	0.000011	0.000011	0.000011
Meter tube calibration temperature	20	20	20
Isentropic Exponent	1.3426	1.3426	1.3473
Dynamic Viscosity (Pa.s)	0.0000121	0.0000121	0.0000121
Orifice plate certificate number	OP50205	OP60166	OP80052
Orifice plate serial number	302	302-1	302
Error in orifice diameter?	No	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 57 bar a; the change in $q_{m,c}/q_{m,o}$ due to changing the static pressure by 10 bar is around 0.00004% at maximum.

Over the period from 14/09/2007 to 20/08/2008 the correction can be calculated as in Table 3; throughout this calculation the meter tube diameter is 432.5747 mm, the isentropic exponent is 1.3426 and the dynamic viscosity 0.0000121 Pa s.

TABLE 3

THE CORRECTION FROM 14/09/2007 TO 20/08/2008

	d mm	β	ε	Re_D	C	$\frac{q_{m,c}}{q_{m,o}}$
Original: Δp=10 mbar	289.3769	0.668964	0.999937	3462058	0.603082	
Corrected Δp=10 mbar	289.6579	0.669614	0.999937	3470332	0.603057	1.0023900
Original Δp=500 mbar	289.3769	0.668964	0.996863	24392169	0.602760	
Corrected Δp=500 mbar	289.6579	0.669614	0.996862	24450416	0.602735	1.0023879

So $q_{m,c}/q_{m,o}$ is 1.002389.

4 CORRECTIONS ON A DAILY BASIS

The volume flows for each day from 14/09/2007 to 20/08/2008 are given in Table B.1 of Appendix B together with the corrected values. It has been assumed that the plates were changed at 08:30 therefore all of the flow for 14/09/2007 has to be corrected but none of that for 20/08/2008. Summing the data gives the figures in Table 5.

TABLE 4

THE FLOW OVER THE PERIOD 14/09/2007 TO 20/08/2008 INCLUSIVE

Flow (mscm)	867.61842
Correction (mscm)	2.07229
Corrected flow (mscm)	869.69071
% change	0.2388

5 CONCLUSIONS

A correction factor of 1.002389 should be applied during the period of mis-measurement.

APPENDIX A
ORIFICE PLATE CALIBRATION CERTIFICATES

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: *30-08-05*

REF NO: *OP4221*

TEMPERATURE: *21 degsC*

MEASURED ORIFICE BORE: *289.655mm*

PLATE DETAILS

PLATE SERIAL.	302-1	PLATE O.D	507.925mm		
MANUFACTURER:		PIPE I.D:	432.5747mm	SITE:	TUR LANGTON
MATERIAL CERT.No		DESIGN BORE:	289.956mm	FLOW:	9 x 10E6 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					7	8
FLATNESS %	0.072	0.063	0.078	0.076	0.069	0.054	0.022	0.061
'E' mm	9.610	9.588	9.580	9.605	9.613	9.610	9.603	9.619
'e' mm	6.746	6.771	6.733	6.682	6.568	6.541	6.566	6.660
EDGE SHARPNESS mm	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125

BEVEL ANGLE: 37 DEGS

CONCENTRICITY 0.082mm

SURFACE FINISH (Ra) 4.8 microns

DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS

ROUNDNESS 0.010mm TAPER 0 degs

COMMENTS:

INSPECTED BY ..... P.KENNERSON

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 13-09-06

REF NO: OP50205

TEMPERATURE: 21 degsC

MEASURED ORIFICE BORE: 289.662mm

PLATE DETAILS

PLATE SERIAL.	302	PLATE O.D	507.974mm		
MANUFACTURER:		PIPE I.D:	432.574mm	SITE:	TUR LANGTON
MATERIAL CERT.No.		DESIGN BORE:	289.661mm	FLOW:	9X10E06 M^3/DAY

TEST EQUIPMENT

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

CALIBRATED BY: QUALITY CONTROL TECHNOLOGY, CERT:- 4820 NEXT CAL DUE:- 14/10/06

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS:-	1	2	3	4	5	7	8
FLATNESS %	0.147	0.121	0.064	0.040	0.114	0.170	0.123
E' mm	9.557	9.557	9.560	9.571	9.573	9.565	9.559
'e' mm	7.242	7.230	7.242	7.253	7.231	7.251	7.255
EDGE SHARPNESS mm	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125

BEVEL ANGLE: 37 DEGS

CONCENTRICITY 0.026mm

SURFACE FINISH (Ra) 2.2 microns

DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS

ROUNDNESS 0.013mm TAPER 0 degs

COMMENTS:

INSPECTED BY... P.KENNERSON, J. Chambers

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 01-12-06

REF NO: OP60166

TEMPERATURE: 21 degsC

MEASURED ORIFICE BORE: 289.3815mm

PLATE DETAILS

PLATE SERIAL.	302-1	PLATE O.D	507.504mm		
MANUFACTURER:		PIPE I.D:	432.574mm	SITE:	TUR LANGTON
MATERIAL CERT.No		DESIGN BORE	289.661mm	FLOW:	9X10E06 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 %	0.068	0.079	0.097	0.087	0.052	0.061	0.057	0.053
'E' mm	9.653	9.570	9.570	9.654	9.660	9.604	9.596	9.663
'e' mm	6.791	6.769	6.726	6.677	6.609	6.540	6.557	6.692
EDGE SHARPNESS mm	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125

BEVEL ANGLE 37 DEGS

CONCENTRICITY 0.141mm

SURFACE FINISH (Ra) 4.9 microns

DOWNSTREAM FACE/EDGE VISUAL INSPECTION PASS

ROUNDNESS 0.282mm TAPER 0 degs

COMMENTS

INSPECTED BY P.KENNERSON

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 15-AUG-2008

REF NO: OP80052

TEMPERATURE: 20.7 degsC

MEASURED ORIFICE BORE: 289.669mm

PLATE DETAILS

PLATE SERIAL.	302	PLATE O.D	507.981mm		
MANUFACTURER:		PIPE I.D:	432.5747mm	SITE:	TUR LANGTON
MATERIAL CERT.No		DESIGN BORE:	289.661mm	FLOW:	9X10E06 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		5	6		
FLATNESS %	0.139	0.114	0.076	0.110	0.139	0.137	0.124	0.127
E' mm	9.554	9.551	9.557	9.563	9.563	9.560	9.550	9.547
e' mm	7.234	7.228	7.231	7.239	7.273	7.270	7.244	7.221
EDGE SHARPNESS mm	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025

BEVEL ANGLE: 37 DEGS

CONCENTRICITY 0.033mm

SURFACE FINISH (Ra) 0.6 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: 29-SEPT-2008

REF NO: OP80060

TEMPERATURE: 20 degsC

MEASURED ORIFICE BORE: 289.6655mm

PLATE DETAILS

PLATE SERIAL.	302-1	PLATE O.D	507.928mm		
MANUFACTURER:		PIPE I.D:	532.5747mm	SITE:	TUR LANGTON
MATERIAL CERT.No.		DESIGN BORE:	289.661mm	FLOW:	9X10E06 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			
FLATNESS %	0.090	0.072	0.080	0.080	0.063	0.056	0.041	0.052				
'E' mm	9.594	9.585	9.586	9.593	9.605	9.620	9.611	9.600				
e' mm	6.751	6.765	6.725	6.634	6.552	6.548	6.578	6.665				
EDGE SHARPNESS mm	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125					

BEVEL ANGLE: 37 DEGS

CONCENTRICITY 0.100mm

SURFACE FINISH (Ra) 1.05 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: 14-AUG-2009

REF NO: OP90033

TEMPERATURE: 20.4 degsC

MEASURED ORIFICE BORE: 289.6685mm

PLATE DETAILS

PLATE SERIAL.	302	PLATE O.D	507.983mm		
MANUFACTURER:		PIPE I.D:	432.5747mm	SITE:	TUR LANGTON
MATERIAL CERT.No		DESIGN BORE:	289.661mm	FLOW:	9 X 10 E06 M^3/DAY

TEST EQUIPMENT

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

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS:	1	2	3	4	5			8
FLATNESS %	0.149	0.128	0.078	0.076	0.120	0.149	0.137	0.115
'E' mm	9.550	9.547	9.553	9.559	9.558	9.563	9.553	9.547
	7.221	7.237	7.226	7.241	7.239	7.266	7.251	7.222
EDGE SHARPNESS mm	0.0125	0.0125	0.025	0.0125	0.025	0.0125	0.025	0.025

BEVEL ANGLE 37 DEGS

CONCENTRICITY 0.031mm

SURFACE FINISH (Ra) 0.65 microns

DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS

ROUNDNESS 0.014mm 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 TUR LANGTON DURING THE PERIOD OF THE MIS-MEASUREMENT

	Original Values (total)	Corrected values (total)	% increase
Date	Volume (mscm)	Volume (mscm)	Volume (mscm)
14-Sep-07	0.08700	**0.08721**	0.2389
15-Sep-07	0.00000	**0.00000**	0.0000
16-Sep-07	0.00000	**0.00000**	0.0000
17-Sep-07	0.02300	**0.02305**	0.2389
18-Sep-07	1.24600	**1.24898**	0.2389
19-Sep-07	2.67700	**2.68340**	0.2389
20-Sep-07	1.60000	**1.60382**	0.2389
21-Sep-07	2.04400	**2.04888**	0.2389
22-Sep-07	2.08900	**2.09399**	0.2389
23-Sep-07	2.09000	**2.09499**	0.2389
24-Sep-07	2.08200	**2.08697**	0.2389
25-Sep-07	2.09100	**2.09600**	0.2389
26-Sep-07	2.51300	**2.51900**	0.2389
27-Sep-07	2.65800	**2.66435**	0.2389
28-Sep-07	2.61700	**2.62325**	0.2389
29-Sep-07	1.98500	**1.98974**	0.2389
30-Sep-07	2.32500	**2.33055**	0.2389
01-Oct-07	2.62200	**2.62826**	0.2389
02-Oct-07	2.36200	**2.36764**	0.2389
03-Oct-07	1.89799	**1.90252**	0.2389
04-Oct-07	1.43100	**1.43442**	0.2389
05-Oct-07	0.00000	**0.00000**	0.0000
06-Oct-07	0.00000	**0.00000**	0.0000
07-Oct-07	0.00000	**0.00000**	0.0000
08-Oct-07	0.47900	**0.48014**	0.2389
09-Oct-07	2.04600	**2.05089**	0.2389
10-Oct-07	1.98000	**1.98473**	0.2389
11-Oct-07	1.98300	**1.98774**	0.2389
12-Oct-07	2.13000	**2.13509**	0.2389
13-Oct-07	2.18600	**2.19122**	0.2389
14-Oct-07	2.18000	**2.18521**	0.2389
15-Oct-07	2.88700	**2.89390**	0.2389
16-Oct-07	3.20300	**3.21065**	0.2389
17-Oct-07	3.42000	**3.42817**	0.2389
18-Oct-07	3.56700	**3.57552**	0.2389
19-Oct-07	3.74800	**3.75695**	0.2389
20-Oct-07	3.49800	**3.50636**	0.2389
21-Oct-07	3.52100	**3.52941**	0.2389
22-Oct-07	3.99001	**3.99954**	0.2389

23-Oct-07	3.43900	**3.44722**	0.2389
24-Oct-07	3.79100	**3.80006**	0.2389
25-Oct-07	3.33701	**3.34498**	0.2389
26-Oct-07	2.94800	**2.95504**	0.2389
27-Oct-07	2.16899	**2.17417**	0.2389
28-Oct-07	1.77901	**1.78326**	0.2389
29-Oct-07	2.16499	**2.17016**	0.2389
30-Oct-07	2.66301	**2.66937**	0.2389
31-Oct-07	2.77899	**2.78563**	0.2389
01-Nov-07	2.72400	**2.73051**	0.2389
02-Nov-07	1.92001	**1.92460**	0.2389
03-Nov-07	2.57599	**2.58214**	0.2389
04-Nov-07	3.37300	**3.38106**	0.2389
05-Nov-07	4.17601	**4.18599**	0.2389
06-Nov-07	4.17700	**4.18698**	0.2389
07-Nov-07	3.26099	**3.26878**	0.2389
08-Nov-07	3.37001	**3.37806**	0.2389
09-Nov-07	3.22400	**3.23170**	0.2389
10-Nov-07	3.00500	**3.01218**	0.2389
11-Nov-07	3.42000	**3.42817**	0.2389
12-Nov-07	4.52100	**4.53180**	0.2389
13-Nov-07	4.32201	**4.33234**	0.2389
14-Nov-07	4.42699	**4.43757**	0.2389
15-Nov-07	5.03500	**5.04703**	0.2389
16-Nov-07	4.38200	**4.39247**	0.2389
17-Nov-07	3.97301	**3.98250**	0.2389
18-Nov-07	4.54199	**4.55284**	0.2389
19-Nov-07	4.28500	**4.29524**	0.2389
20-Nov-07	3.81700	**3.82612**	0.2389
21-Nov-07	3.64000	**3.64870**	0.2389
22-Nov-07	3.68800	**3.69681**	0.2389
23-Nov-07	4.42299	**4.43356**	0.2389
24-Nov-07	4.59100	**4.60197**	0.2389
25-Nov-07	3.71800	**3.72688**	0.2389
26-Nov-07	4.17300	**4.18297**	0.2389
27-Nov-07	3.91899	**3.92835**	0.2389
28-Nov-07	3.83200	**3.84115**	0.2389
29-Nov-07	4.22400	**4.23409**	0.2389
30-Nov-07	3.78900	**3.79805**	0.2389
01-Dec-07	3.79901	**3.80809**	0.2389
02-Dec-07	4.38901	**4.39950**	0.2389
03-Dec-07	3.88998	**3.89927**	0.2389
04-Dec-07	3.80402	**3.81311**	0.2389
05-Dec-07	3.64999	**3.65871**	0.2389
06-Dec-07	3.60001	**3.60861**	0.2389
07-Dec-07	4.25098	**4.26114**	0.2389
08-Dec-07	4.12601	**4.13587**	0.2389
09-Dec-07	3.95502	**3.96447**	0.2389

10-Dec-07	4.77298	**4.78438**	0.2389
11-Dec-07	5.20300	**5.21543**	0.2389
12-Dec-07	5.45099	**5.46401**	0.2389
13-Dec-07	5.40802	**5.42094**	0.2389
14-Dec-07	5.59100	**5.60436**	0.2389
15-Dec-07	5.19598	**5.20839**	0.2389
16-Dec-07	5.38300	**5.39586**	0.2389
17-Dec-07	5.61102	**5.62442**	0.2389
18-Dec-07	5.38000	**5.39285**	0.2389
19-Dec-07	5.51199	**5.52516**	0.2389
20-Dec-07	5.52100	**5.53419**	0.2389
21-Dec-07	5.45801	**5.47105**	0.2389
22-Dec-07	4.78198	**4.79340**	0.2389
23-Dec-07	4.88699	**4.89867**	0.2389
24-Dec-07	4.19400	**4.20402**	0.2389
25-Dec-07	3.29001	**3.29787**	0.2389
26-Dec-07	3.61002	**3.61864**	0.2389
27-Dec-07	3.97699	**3.98649**	0.2389
28-Dec-07	3.97699	**3.98649**	0.2389
29-Dec-07	3.66501	**3.67377**	0.2389
30-Dec-07	3.47501	**3.48331**	0.2389
31-Dec-07	3.47101	**3.47930**	0.2389
01-Jan-08	3.50299	**3.51136**	0.2389
02-Jan-08	5.11099	**5.12320**	0.2389
03-Jan-08	5.79199	**5.80583**	0.2389
04-Jan-08	5.06003	**5.07212**	0.2389
05-Jan-08	4.29999	**4.31026**	0.2389
06-Jan-08	4.61398	**4.62500**	0.2389
07-Jan-08	5.06201	**5.07410**	0.2389
08-Jan-08	4.61002	**4.62103**	0.2389
09-Jan-08	4.36398	**4.37441**	0.2389
10-Jan-08	4.17502	**4.18499**	0.2389
11-Jan-08	4.66299	**4.67413**	0.2389
12-Jan-08	4.32300	**4.33333**	0.2389
13-Jan-08	3.82001	**3.82914**	0.2389
14-Jan-08	4.22000	**4.23008**	0.2389
15-Jan-08	4.12799	**4.13785**	0.2389
16-Jan-08	4.30200	**4.31228**	0.2389
17-Jan-08	4.18799	**4.19800**	0.2389
18-Jan-08	3.55499	**3.56348**	0.2389
19-Jan-08	3.17102	**3.17860**	0.2389
20-Jan-08	2.92798	**2.93497**	0.2389
21-Jan-08	3.76202	**3.77101**	0.2389
22-Jan-08	4.39099	**4.40148**	0.2389
23-Jan-08	3.76599	**3.77499**	0.2389
24-Jan-08	4.05099	**4.06067**	0.2389
25-Jan-08	4.02502	**4.03464**	0.2389
26-Jan-08	3.61398	**3.62261**	0.2389

27-Jan-08	3.44202	**3.45024**	0.2389
28-Jan-08	3.88498	**3.89426**	0.2389
29-Jan-08	4.30200	**4.31228**	0.2389
30-Jan-08	4.42199	**4.43255**	0.2389
31-Jan-08	4.84802	**4.85960**	0.2389
01-Feb-08	5.14600	**5.15829**	0.2389
02-Feb-08	5.10297	**5.11516**	0.2389
03-Feb-08	4.71503	**4.72629**	0.2389
04-Feb-08	4.11798	**4.12782**	0.2389
05-Feb-08	3.84204	**3.85122**	0.2389
06-Feb-08	4.31299	**4.32329**	0.2389
07-Feb-08	3.90802	**3.91736**	0.2389
08-Feb-08	3.35095	**3.35896**	0.2389
09-Feb-08	3.29004	**3.29790**	0.2389
10-Feb-08	3.48596	**3.49429**	0.2389
11-Feb-08	4.24902	**4.25917**	0.2389
12-Feb-08	4.38000	**4.39046**	0.2389
13-Feb-08	4.42102	**4.43158**	0.2389
14-Feb-08	4.78497	**4.79640**	0.2389
15-Feb-08	4.77502	**4.78643**	0.2389
16-Feb-08	4.82996	**4.84150**	0.2389
17-Feb-08	4.95099	**4.96282**	0.2389
18-Feb-08	5.59705	**5.61042**	0.2389
19-Feb-08	5.70001	**5.71363**	0.2389
20-Feb-08	5.28497	**5.29760**	0.2389
21-Feb-08	4.34601	**4.35639**	0.2389
22-Feb-08	3.47198	**3.48027**	0.2389
23-Feb-08	3.29401	**3.30188**	0.2389
24-Feb-08	3.32703	**3.33498**	0.2389
25-Feb-08	4.10596	**4.11577**	0.2389
26-Feb-08	3.79901	**3.80809**	0.2389
27-Feb-08	3.75201	**3.76097**	0.2389
28-Feb-08	4.15601	**4.16594**	0.2389
29-Feb-08	4.59998	**4.61097**	0.2389
01-Mar-08	3.97900	**3.98851**	0.2389
02-Mar-08	3.60803	**3.61665**	0.2389
03-Mar-08	4.43896	**4.44956**	0.2389
04-Mar-08	4.52100	**4.53180**	0.2389
05-Mar-08	4.35999	**4.37041**	0.2389
06-Mar-08	3.47705	**3.48536**	0.2389
07-Mar-08	3.35699	**3.36501**	0.2389
08-Mar-08	3.66296	**3.67171**	0.2389
09-Mar-08	3.39203	**3.40013**	0.2389
10-Mar-08	4.46399	**4.47465**	0.2389
11-Mar-08	4.65802	**4.66915**	0.2389
12-Mar-08	4.33099	**4.34134**	0.2389
13-Mar-08	3.83698	**3.84615**	0.2389
14-Mar-08	3.38202	**3.39010**	0.2389

15-Mar-08	3.15802	**3.16556**	0.2389
16-Mar-08	4.17700	**4.18698**	0.2389
17-Mar-08	4.49695	**4.50769**	0.2389
18-Mar-08	4.51300	**4.52378**	0.2389
19-Mar-08	4.30701	**4.31730**	0.2389
20-Mar-08	4.42804	**4.43862**	0.2389
21-Mar-08	4.25598	**4.26615**	0.2389
22-Mar-08	4.66803	**4.67918**	0.2389
23-Mar-08	4.63495	**4.64602**	0.2389
24-Mar-08	4.59900	**4.60999**	0.2389
25-Mar-08	4.43805	**4.44865**	0.2389
26-Mar-08	4.30298	**4.31326**	0.2389
27-Mar-08	3.68097	**3.68976**	0.2389
28-Mar-08	3.69305	**3.70187**	0.2389
29-Mar-08	3.58600	**3.59457**	0.2389
30-Mar-08	2.66699	**2.67336**	0.2389
31-Mar-08	3.41797	**3.42614**	0.2389
01-Apr-08	2.84239	**2.84918**	0.2389
02-Apr-08	3.19000	**3.19762**	0.2389
03-Apr-08	3.04303	**3.05030**	0.2389
04-Apr-08	2.54901	**2.55510**	0.2389
05-Apr-08	2.61395	**2.62019**	0.2389
06-Apr-08	3.88702	**3.89631**	0.2389
07-Apr-08	4.46301	**4.47367**	0.2389
08-Apr-08	3.88800	**3.89729**	0.2389
09-Apr-08	4.32300	**4.33333**	0.2389
10-Apr-08	3.35498	**3.36300**	0.2389
11-Apr-08	3.67499	**3.68377**	0.2389
12-Apr-08	3.20105	**3.20870**	0.2389
13-Apr-08	3.26697	**3.27477**	0.2389
14-Apr-08	3.70502	**3.71387**	0.2389
15-Apr-08	4.03198	**4.04161**	0.2389
16-Apr-08	3.81903	**3.82815**	0.2389
17-Apr-08	3.85596	**3.86517**	0.2389
18-Apr-08	4.11200	**4.12182**	0.2389
19-Apr-08	3.60303	**3.61164**	0.2389
20-Apr-08	3.72699	**3.73589**	0.2389
21-Apr-08	3.53900	**3.54745**	0.2389
22-Apr-08	2.99200	**2.99915**	0.2389
23-Apr-08	2.89899	**2.90592**	0.2389
24-Apr-08	2.30701	**2.31252**	0.2389
25-Apr-08	2.60199	**2.60821**	0.2389
26-Apr-08	1.34399	**1.34720**	0.2389
27-Apr-08	0.00000	**0.00000**	0.0000
28-Apr-08	0.00000	**0.00000**	0.0000
29-Apr-08	0.00000	**0.00000**	0.0000
30-Apr-08	0.00000	**0.00000**	0.0000
01-May-08	0.00000	**0.00000**	0.0000

02-May-08	0.07104	**0.07121**	0.2389
03-May-08	0.00000	**0.00000**	0.0000
04-May-08	0.00000	**0.00000**	0.0000
05-May-08	0.00000	**0.00000**	0.0000
06-May-08	0.00000	**0.00000**	0.0000
07-May-08	0.00000	**0.00000**	0.0000
08-May-08	0.00000	**0.00000**	0.0000
09-May-08	0.00000	**0.00000**	0.0000
10-May-08	0.00000	**0.00000**	0.0000
11-May-08	0.00000	**0.00000**	0.0000
12-May-08	0.00000	**0.00000**	0.0000
13-May-08	0.00000	**0.00000**	0.0000
14-May-08	2.47595	**2.48187**	0.2389
15-May-08	2.47400	**2.47991**	0.2389
16-May-08	2.89502	**2.90194**	0.2389
17-May-08	3.25500	**3.26278**	0.2389
18-May-08	3.26501	**3.27281**	0.2389
19-May-08	2.99097	**2.99812**	0.2389
20-May-08	2.53802	**2.54408**	0.2389
21-May-08	2.45502	**2.46089**	0.2389
22-May-08	1.97296	**1.97767**	0.2389
23-May-08	2.16101	**2.16617**	0.2389
24-May-08	1.98499	**1.98973**	0.2389
25-May-08	2.18402	**2.18924**	0.2389
26-May-08	2.56299	**2.56911**	0.2389
27-May-08	2.75903	**2.76562**	0.2389
28-May-08	2.47595	**2.48187**	0.2389
29-May-08	2.00000	**2.00478**	0.2389
30-May-08	1.98401	**1.98875**	0.2389
31-May-08	0.03503	**0.03511**	0.2389
01-Jun-08	0.00000	**0.00000**	0.0000
02-Jun-08	0.00000	**0.00000**	0.0000
03-Jun-08	0.00000	**0.00000**	0.0000
04-Jun-08	0.00000	**0.00000**	0.0000
05-Jun-08	0.00000	**0.00000**	0.0000
06-Jun-08	0.00000	**0.00000**	0.0000
07-Jun-08	0.00000	**0.00000**	0.0000
08-Jun-08	0.00000	**0.00000**	0.0000
09-Jun-08	0.00000	**0.00000**	0.0000
10-Jun-08	0.00000	**0.00000**	0.0000
11-Jun-08	1.06000	**1.06253**	0.2389
12-Jun-08	0.00000	**0.00000**	0.0000
13-Jun-08	0.00000	**0.00000**	0.0000
14-Jun-08	0.00000	**0.00000**	0.0000
15-Jun-08	0.00000	**0.00000**	0.0000
16-Jun-08	0.00000	**0.00000**	0.0000
17-Jun-08	0.53601	**0.53729**	0.2389
18-Jun-08	0.00000	**0.00000**	0.0000

19-Jun-08	0.00000	**0.00000**	0.0000
20-Jun-08	0.00000	**0.00000**	0.0000
21-Jun-08	0.00000	**0.00000**	0.0000
22-Jun-08	0.00000	**0.00000**	0.0000
23-Jun-08	0.00000	**0.00000**	0.0000
24-Jun-08	0.00000	**0.00000**	0.0000
25-Jun-08	0.00000	**0.00000**	0.0000
26-Jun-08	0.00000	**0.00000**	0.0000
27-Jun-08	0.00000	**0.00000**	0.0000
28-Jun-08	0.00000	**0.00000**	0.0000
29-Jun-08	0.00000	**0.00000**	0.0000
30-Jun-08	0.00000	**0.00000**	0.0000
01-Jul-08	0.00000	**0.00000**	0.0000
02-Jul-08	0.00000	**0.00000**	0.0000
03-Jul-08	0.00000	**0.00000**	0.0000
04-Jul-08	0.00000	**0.00000**	0.0000
05-Jul-08	0.00000	**0.00000**	0.0000
06-Jul-08	0.00000	**0.00000**	0.0000
07-Jul-08	0.00000	**0.00000**	0.0000
08-Jul-08	0.00000	**0.00000**	0.0000
09-Jul-08	0.00000	**0.00000**	0.0000
10-Jul-08	0.00000	**0.00000**	0.0000
11-Jul-08	0.10199	**0.10223**	0.2389
12-Jul-08	0.00000	**0.00000**	0.0000
13-Jul-08	0.00000	**0.00000**	0.0000
14-Jul-08	0.00000	**0.00000**	0.0000
15-Jul-08	0.00000	**0.00000**	0.0000
16-Jul-08	0.00000	**0.00000**	0.0000
17-Jul-08	0.00000	**0.00000**	0.0000
18-Jul-08	0.00000	**0.00000**	0.0000
19-Jul-08	0.00000	**0.00000**	0.0000
20-Jul-08	0.00000	**0.00000**	0.0000
21-Jul-08	0.00000	**0.00000**	0.0000
22-Jul-08	0.00000	**0.00000**	0.0000
23-Jul-08	0.00000	**0.00000**	0.0000
24-Jul-08	0.00000	**0.00000**	0.0000
25-Jul-08	0.01800	**0.01804**	0.2389
26-Jul-08	0.00000	**0.00000**	0.0000
27-Jul-08	0.00000	**0.00000**	0.0000
28-Jul-08	0.00000	**0.00000**	0.0000
29-Jul-08	0.00000	**0.00000**	0.0000
30-Jul-08	0.00000	**0.00000**	0.0000
31-Jul-08	0.00000	**0.00000**	0.0000
01-Aug-08	0.00000	**0.00000**	0.0000
02-Aug-08	0.00000	**0.00000**	0.0000
03-Aug-08	0.00000	**0.00000**	0.0000
04-Aug-08	0.00000	**0.00000**	0.0000
05-Aug-08	0.00000	**0.00000**	0.0000

06-Aug-08	0.00000	**0.00000**	0.0000
07-Aug-08	0.00000	**0.00000**	0.0000
08-Aug-08	0.00000	**0.00000**	0.0000
09-Aug-08	0.00000	**0.00000**	0.0000
10-Aug-08	0.00000	**0.00000**	0.0000
11-Aug-08	0.00000	**0.00000**	0.0000
12-Aug-08	0.05896	**0.05910**	0.2389
13-Aug-08	0.00000	**0.00000**	0.0000
14-Aug-08	0.00000	**0.00000**	0.0000
15-Aug-08	0.00000	**0.00000**	0.0000
16-Aug-08	0.00000	**0.00000**	0.0000
17-Aug-08	0.00000	**0.00000**	0.0000
18-Aug-08	0.05399	**0.05412**	0.2389
19-Aug-08	0.10605	**0.10630**	0.2389
20-Aug-08	0.18903	**0.18903**	0.0000