



ASSESSMENT OF ERROR DUE TO ORIFICE DIAMETER MIS-MEASUREMENT AT HOLMES CHAPEL

A Report for

**National Grid
Brick Kiln Street
HINCKLEY
Leicestershire
LE10 0NA**

PROJECT NO: NGR010

REPORT NO: 2010/225

DATE: 16 JUNE 2010



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

NOTES

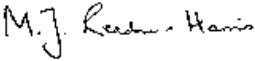
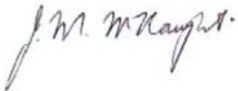
- 1** This report may be published in full by the client unless it includes information supplied in confidence by TUV NEL Ltd or any third party. Such information, if included within the report, shall be identified as confidential by TUV NEL Ltd.
- 2a** The prior written consent of TUV NEL Ltd shall 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 Holmes Chapel

A Report for

National Grid
Brick Kiln Street
HINCKLEY
Leicestershire
LE10 0NA

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 Holmes Chapel a correction factor of 1.002755 should be applied during the period of mis-measurement.

Over the period 10/07/2007 to 07/07/2008 inclusive the flow was 346.89150 mscm and the corrected flow should be 347.84543 mscm.

CONTENTS

	Page No
EXECUTIVE SUMMARY	2
1 INTRODUCTION	4
2 ORIFICE DIAMETERS	4
3 CORRECTING THE FLOWRATE	5
4 CORRECTIONS ON A DAILY BASIS	6
5 CONCLUSIONS	6
APPENDIX A ORIFICE PLATE CALIBRATION CERTIFICATES	7
APPENDIX B CORRECTED DAILY VOLUME FLOWS.....	15

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 Holmes Chapel in the period of the error. The Joint Office Error Code is NW004.

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

Calibration Reference	Plate serial no	Declared certificate date	Orifice bore (mm)	Temperature	Value at 20 °C Orifice bore (mm)
OP4106	214-4	19/07/2004	136.2100	21	136.2078
OP4177	214-6	23/09/2004	136.2100	21	136.2078
OP60029	214-6	22/02/2006	136.2050	21	136.2028
OP60061	214-4	19/07/2006	136.2085	20	136.2085
OP60160	214-6	03/07/2007	136.0565	21	136.0543
OP80013	214-4	08/05/2008	136.2085	20	136.2085
OP80038	214-6	11/07/2008	136.2065	20	136.2065
OP90030	214-4	11/08/2009	136.2080	20.5	136.2069

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.

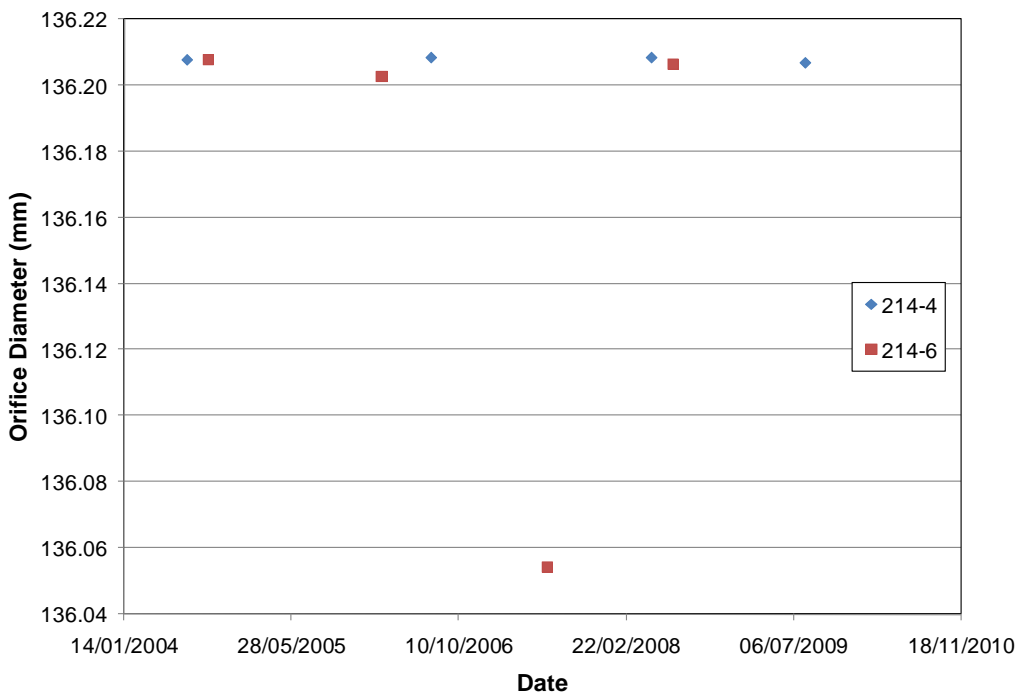


Figure 1 Orifice Diameters at 20 °C

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	omnL1011.cfg	omnM0710.cfg	omnN0707.cfg
	11/10/2006 23:01	10/07/2007 23:01	07/07/2008 23:01
Orifice plate bore diameter (mm)	136.2085	136.0565	136.2085
Expansion coefficient of the plate (1/°C)	0.000016	0.000016	0.000016
Orifice plate calibration temperature	20	21	20
Meter tube diameter (mm)	202.746	202.746	202.746
Expansion coefficient of the meter tube (1/°C)	0.000011	0.000011	0.000011
Meter tube calibration temperature	20	20	20
Isentropic Exponent	1.3423	1.3446	1.3477
Dynamic Viscosity (Pa.s)	0.0000122	0.0000121	0.0000122
Orifice plate certificate number	OP60061	OP60160	OP80013
Orifice plate serial number	214-4	214-6	214-4
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:

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

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 0.00004% at maximum.

Over the period from 10/07/2007 to 07/07/2008 the correction can be calculated as in Table 3; throughout this calculation the meter tube diameter is 202.746 mm, the isentropic exponent is 1.3446 and the dynamic viscosity 0.0000121 Pa s.

TABLE 3
THE CORRECTION FROM 10/07/2007 TO 07/07/2008

	d mm	β	ε	Re_D	C	$\frac{q_{m,c}}{q_{m,o}}$
Original: $\Delta p=10$ mbar	136.0543	0.671058	0.999940	1669680	0.604155	
Corrected $\Delta p=10$ mbar	136.2057	0.671805	0.999940	1674281	0.604131	1.0027560
Original $\Delta p=500$ mbar	136.0543	0.671058	0.997019	11761005	0.603595	
Corrected $\Delta p=500$ mbar	136.2057	0.671805	0.997017	11793388	0.603571	1.0027534

So $q_{m,c}/q_{m,o}$ is 1.002755.

4 CORRECTIONS ON A DAILY BASIS

The volume flows for each day from 10/07/2007 to 07/07/2008 are given in Table B.1 of Appendix B together with the corrected values. It has been assumed that the plates were changed at 10:30; therefore 79.5% of the flow for 10/07/2007 has to be corrected and 16.6% of the flow for 07/07/2008 has to be corrected based on the flow before and after 10:30. Summing the data gives the figures in Table 5.

TABLE 5
THE FLOW OVER THE PERIOD 10/07/2007 TO 07/07/2008 INCLUSIVE

Flow (mscm)	346.89150
Correction (mscm)	0.95393
Corrected flow (mscm)	347.84543
% change	0.2750

5 CONCLUSIONS

A correction factor of 1.002755 should be applied during the period of mis-measurement.

APPENDIX A
ORIFICE PLATE CALIBRATION CERTIFICATES
TRANSCO ORIFICE PLATE CALIBRATION

DATE: 19-07-04

REF NO: OP4106

TEMPERATURE: 21 degsC

MEASURED ORIFICE BORE: 136.21mm

PLATE DETAILS

PLATE SERIAL.	214-4	PLATE O.D	214.165mm	SITE	HOLMES CHAPEL
MANUFACTURER:		PIPE I.D:	mm	FLOW	
MATERIAL CERT.No		DESIGN BORE:	mm		

TEST EQUIPMENT

MANUFACTURER & TYPE: KEMCO 700 MANUAL 3-DIMENSIONAL MEASURING MACHINE -ASSET NO OP-A02
 CALIBRATED BY: QUALITY CONTROL TECHNOLOGY, CERT:- 3858 NEXT CAL DUE:- 17/10/04

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS:	1	2	4	5	6	7	8	
FLATNESS %	0.248	0.264	0.162	0.099	0.146	0.291	0.224	0.115
mm	3.075	3.089	3.047	3.058	3.069	3.059	3.067	3.054
EDGE SHARPNESS mm	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125
CONCENTRICITY	0.031mm							
SURFACE FINISH (Ra)	0.5 microns							
DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS								
ROUNDNESS	0.038mm	TAPER	0 degs					

BEVEL ANGLE

COMMENTS:

INSPECTED BY  G. WARDLE

VERIFIED BY  P. KENNERSON

TRANSCO ORIFICE PLATE CALIBRATION

DATE: 23-09-04
REF NO: OP4177
TEMPERATURE: 21 degsC
MEASURED ORIFICE BORE: 136.21mm

PLATE DETAILS

PLATE SERIAL. 214-6 PLATE O.D 214.287mm
 MANUFACTURER: PIPE I.D: 202.768mm SITE HOLMES CHAPEL
 MATERIAL CERT.No. DESIGN BORE 136.220mm FLOW

TEST EQUIPMENT

MANUFACTURER & TYPE: KEMCO 700 MANUAL 3-DIMENSIONAL MEASURING MACHINE -ASSET NO OP-A02
 CALIBRATED BY: QUALITY CONTROL TECHNOLOGY, CERT:- 3858 NEXT CAL DUE:- 17/10/04

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS:	1	2	4	5	6	7	8	
FLATNESS μ	0.053	0.008	0.068	0.035	0.189	0.018	0.001	0.000
FE mm	3.202	3.205	3.193	3.204	3.187	3.196	3.192	3.193
EDGE SHARPNESS mm	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125
CONCENTRICITY	0.166mm							
SURFACE FINISH (Ra)	1.2 microns							
DOWNSTREAM FACE/EDGE VISUAL INSPECTION	PASS							
ROUNDNESS 0.020mm	TAPER: 0 degs							
BEVEL ANGLE	DEGS							

COMMENTS

INSPECTED BY  P. KENNERSON
 VERIFIED BY P. KENNERSON

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 22-02-06
 REF NO: OP60029
 TEMPERATURE: 21 degsC

MEASURED ORIFICE BORE: 136.205mm

PLATE DETAILS

PLATE SERIAL. 214-6 PLATE O.D 214.296mm
 MANUFACTURER: PIPE I.D: 202.768mm SITE: HOLMES CHAPEL
 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:- 14/10/06

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS:-	1	2	3	4	5	6	7	
FLATNESS %	0.018	0.072	0.016	0.065	0.012	0.137	0.004	0.006
E' mm	3.198	3.203	3.202	3.200	3.211	3.211	3.198	3.186
'e'								
EDGE SHARPNESS mm	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125
BEVEL ANGLE:	DEGS							
CONCENTRICITY	0.151mm							
SURFACE FINISH (Ra)	1.2 microns							

DOWNSTREAM FACE/EDGE VISUAL INSPECTION

ROUNDNESS : 0.030mm TAPER: 0 degs

COMMENTS:

INSPECTED BY:  P.KENNERSON

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 19-07-06
REF NO: OP60061
TEMPERATURE: 20 degsC

MEASURED ORIFICE BORE: 136.2085mm

PLATE DETAILS

PLATE SERIAL. 214-4 PLATE O.D 214.167mm
 MANUFACTURER: PIPE I.D: mm SITE HOLMES CHAPLE
 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:- 14/10/06

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS:	1	2	4	5	6	8		
FLATNESS μ	0.177	0.302	0.192	0.141	0.135	0.245	0.275	0.118
E' mm		3.060	3.069	3.061	3.076	3.072	3.044	3.069
EDGE SHARPNESS mm	0.0125	0.0125	0.0125	0.0125	SQUARE	SQUARE	0.0125	0.0125
BEVEL ANGLE:	DEGS							
CONCENTRICITY	0.035mm							
SURFACE FINISH (Ra)	0.6 microns							
DOWNSTREAM FACE/EDGE VISUAL INSPECTION	PASS							
ROUNDNESS	0.033mm	TAPER	0 degs					

COMMENTS

INSPECTED BY  P. KENNERSON /  J. CHAPMAN

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 03-07-2007

REF NO: OP60160

TEMPERATURE: 21 degsC

MEASURED ORIFICE BORE: 136.0565mm

PLATE DETAILS

PLATE SERIAL.	214-6	PLATE O.D	214.137mm		
MANUFACTURER:		PIPE I.D:	202.768mm	SITE:	HOLMES CHAPEL
MATERIAL CERT.No.		DESIGN BORE	136.22mm	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	4	5	6	7	8	
FLATNESS %	0.068	0.035	0.045	0.086	0.144	0.067	0.024	0.051
RE mm	3.242	3.244	3.186	3.180	3.262	3.263	3.182	3.178
RE mm								
EDGE SHARPNESS mm	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125
BEVEL ANGLE:	DEGS							
CONCENTRICITY	0.129mm							
SURFACE FINISH (Ra)	1.4 microns							
DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS								
ROUNDNESS	0.147mm	TAPER:	0 degs					

COMMENTS:

INSPECTED BY



NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 08-MAY-2008
REF NO: OP80013
TEMPERATURE: 20 degsC
MEASURED ORIFICE BORE: 136.2085mm

PLATE DETAILS

PLATE SERIAL. 214-4 PLATE O.D 214.171mm
 MANUFACTURER: PIPE I.D: 202.746mm SITE: HOLMES CHAPEL
 MATERIAL CERT.No. DESIGN BORE: 136.22mm FLOW: M^3/DAY

TEST EQUIPMENT

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

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS:-	1	2	3	4	5	6	7	8
FLATNESS %	0.099	0.040	0.105	0.154	0.076	0.029	0.089	0.122
'E' mm	3.059	3.054	3.078	3.062	3.051	3.049	3.037	3.059
'e'								
EDGE SHARPNESS mm	0.025	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125
BEVEL ANGLE	DEGS							
CONCENTRICITY	0.032mm							
SURFACE FINISH (Ra)	.3 microns							

DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS

ROUNDNESS 0.033mm TAPER: 0 degs

COMMENTS: CLEAN PLATE

INSPECTED BY:  M Livingstone.

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 11-JULY-2008
REF NO: OP80038
TEMPERATURE: 20 degsC
MEASURED ORIFICE BORE: 136.2065mm

PLATE DETAILS

PLATE SERIAL.	214-6	PLATE O.D	214.286mm		
MANUFACTURER:		PIPE I.D:	202.746mm	SITE	HOLMES CHAPEL
MATERIAL CERT.No		DESIGN BORE:	136.22mm	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.

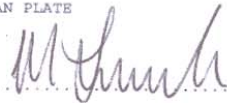
UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS	1	2	3	4	5	6	7	8
FLATNESS μ	0.037	0.064	0.064	0.083	0.089	0.049	0.007	0.023
RE mm	3.197	3.196	3.200		3.194	3.194	3.198	3.198
EDGE SHARPNESS mm	SQUARE	0.0125	0.0125	0.0125	SQUARE	0.0125	SQUARE	SQUARE
BEVEL ANGLE:	DEGS							
CONCENTRICITY	0.156mm							
SURFACE FINISH (Ra	0.45 microns							
DOWNSTREAM FACE/EDGE VISUAL INSPECTION	PASS							
ROUNDNESS 0.022mm	TAPER		0 degs					

DRAINHOLE PRESENT ? (YES/NO) No

COMMENTS: CLEAN PLATE

INSPECTED BY...



M Livingstone

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 11-AUG-2009
REF NO: OP90030
TEMPERATURE: 20.5 degsC
MEASURED ORIFICE BORE: 136.208mm

PLATE DETAILS

PLATE SERIAL:	214-4	PLATE O.D	214.165mm		
MANUFACTURER:		PIPE I.D:	202.746mm	SITE	HOLMES CHAPEL
MATERIAL CERT.No		DESIGN BORE:	136.22mm	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

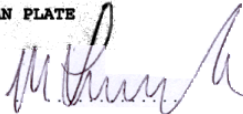
UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS	1	2	3	4	5	6	7	
FLATNESS μ	0.088	0.101	0.114	0.159	0.172	0.114	0.107	0.170
'E' mm	3.050	3.060	3.047	3.072	3.066	3.052	3.070	
'e' mm								
EDGE SHARPNESS mm	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125
BEVEL ANGLE:	DEGS							
CONCENTRICITY	0.035mm							
SURFACE FINISH (Ra)	0.5 microns							
DOWNSTREAM FACE/EDGE VISUAL INSPECTION	PASS							
ROUNDNESS 0.030mm	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 HOLMES CHAPEL DURING THE PERIOD OF THE MIS-MEASUREMENT

	Original Values (total)	Corrected values (total)	% increase
Date	Volume (mscm)	Volume (mscm)	Volume (mscm)
10-Jul-07	0.55801	0.55911	0.1973
11-Jul-07	0.54279	0.54429	0.2755
12-Jul-07	0.48191	0.48324	0.2755
13-Jul-07	0.54440	0.54590	0.2755
14-Jul-07	0.51390	0.51532	0.2755
15-Jul-07	0.57960	0.58120	0.2755
16-Jul-07	0.58490	0.58651	0.2755
17-Jul-07	0.53220	0.53367	0.2755
18-Jul-07	0.45220	0.45345	0.2755
19-Jul-07	0.48290	0.48423	0.2755
20-Jul-07	0.58120	0.58280	0.2755
21-Jul-07	0.59330	0.59493	0.2755
22-Jul-07	0.55800	0.55954	0.2755
23-Jul-07	0.48510	0.48644	0.2755
24-Jul-07	0.50730	0.50870	0.2755
25-Jul-07	0.48660	0.48794	0.2755
26-Jul-07	0.58800	0.58962	0.2755
27-Jul-07	0.51080	0.51221	0.2755
28-Jul-07	0.49220	0.49356	0.2755
29-Jul-07	0.52220	0.52364	0.2755
30-Jul-07	0.51790	0.51933	0.2755
31-Jul-07	0.50950	0.51090	0.2755
01-Aug-07	0.47400	0.47531	0.2755
02-Aug-07	0.50140	0.50278	0.2755
03-Aug-07	0.48510	0.48644	0.2755
04-Aug-07	0.48680	0.48814	0.2755
05-Aug-07	0.43920	0.44041	0.2755
06-Aug-07	0.42830	0.42948	0.2755
07-Aug-07	0.49330	0.49466	0.2755
08-Aug-07	0.49800	0.49937	0.2755
09-Aug-07	0.52420	0.52564	0.2755
10-Aug-07	0.56110	0.56265	0.2755
11-Aug-07	0.49540	0.49676	0.2755
12-Aug-07	0.52380	0.52524	0.2755
13-Aug-07	0.53630	0.53778	0.2755
14-Aug-07	0.43870	0.43991	0.2755
15-Aug-07	0.57210	0.57368	0.2755
16-Aug-07	0.63570	0.63745	0.2755
17-Aug-07	0.54130	0.54279	0.2755

18-Aug-07	0.59060	0.59223	0.2755
19-Aug-07	0.57220	0.57378	0.2755
20-Aug-07	0.61780	0.61950	0.2755
21-Aug-07	0.61450	0.61619	0.2755
22-Aug-07	0.50850	0.50990	0.2755
23-Aug-07	0.50040	0.50178	0.2755
24-Aug-07	0.49550	0.49687	0.2755
25-Aug-07	0.50190	0.50328	0.2755
26-Aug-07	0.51540	0.51682	0.2755
27-Aug-07	0.52330	0.52474	0.2755
28-Aug-07	0.68130	0.68318	0.2755
29-Aug-07	0.49690	0.49827	0.2755
30-Aug-07	0.54720	0.54871	0.2755
31-Aug-07	0.58550	0.58711	0.2755
01-Sep-07	0.47700	0.47831	0.2755
02-Sep-07	0.43440	0.43560	0.2755
03-Sep-07	0.52650	0.52795	0.2755
04-Sep-07	0.48800	0.48934	0.2755
05-Sep-07	0.41140	0.41253	0.2755
06-Sep-07	0.44500	0.44623	0.2755
07-Sep-07	0.40030	0.40140	0.2755
08-Sep-07	0.43320	0.43439	0.2755
09-Sep-07	0.59700	0.59864	0.2755
10-Sep-07	0.55200	0.55352	0.2755
11-Sep-07	0.53650	0.53798	0.2755
12-Sep-07	0.59550	0.59714	0.2755
13-Sep-07	0.55090	0.55242	0.2755
14-Sep-07	0.56420	0.56575	0.2755
15-Sep-07	0.63000	0.63174	0.2755
16-Sep-07	0.53830	0.53978	0.2755
17-Sep-07	0.84460	0.84693	0.2755
18-Sep-07	0.78650	0.78867	0.2755
19-Sep-07	0.80970	0.81193	0.2755
20-Sep-07	0.73750	0.73953	0.2755
21-Sep-07	0.81470	0.81694	0.2755
22-Sep-07	0.65920	0.66102	0.2755
23-Sep-07	0.71720	0.71918	0.2755
24-Sep-07	0.77770	0.77984	0.2755
25-Sep-07	0.84760	0.84994	0.2755
26-Sep-07	0.87560	0.87801	0.2755
27-Sep-07	1.07260	1.07556	0.2755
28-Sep-07	0.95580	0.95843	0.2755
29-Sep-07	0.89000	0.89245	0.2755
30-Sep-07	0.91730	0.91983	0.2755
01-Oct-07	0.88800	0.89045	0.2755
02-Oct-07	0.76590	0.76801	0.2755
03-Oct-07	0.76100	0.76310	0.2755
04-Oct-07	1.00040	1.00316	0.2755

05-Oct-07	0.84620	0.84853	0.2755
06-Oct-07	0.88920	0.89165	0.2755
07-Oct-07	0.92050	0.92304	0.2755
08-Oct-07	0.91750	0.92003	0.2755
09-Oct-07	0.94350	0.94610	0.2755
10-Oct-07	0.91600	0.91852	0.2755
11-Oct-07	0.94280	0.94540	0.2755
12-Oct-07	0.76390	0.76600	0.2755
13-Oct-07	0.79780	0.80000	0.2755
14-Oct-07	0.89560	0.89807	0.2755
15-Oct-07	0.91310	0.91562	0.2755
16-Oct-07	1.02270	1.02552	0.2755
17-Oct-07	1.05830	1.06122	0.2755
18-Oct-07	1.20960	1.21293	0.2755
19-Oct-07	1.18070	1.18395	0.2755
20-Oct-07	1.16140	1.16460	0.2755
21-Oct-07	1.11640	1.11948	0.2755
22-Oct-07	1.19440	1.19769	0.2755
23-Oct-07	1.21830	1.22166	0.2755
24-Oct-07	1.23890	1.24231	0.2755
25-Oct-07	1.14510	1.14825	0.2755
26-Oct-07	1.15170	1.15487	0.2755
27-Oct-07	0.97560	0.97829	0.2755
28-Oct-07	0.87460	0.87701	0.2755
29-Oct-07	1.03270	1.03555	0.2755
30-Oct-07	1.05550	1.05841	0.2755
31-Oct-07	0.96780	0.97047	0.2755
01-Nov-07	1.03520	1.03805	0.2755
02-Nov-07	0.92950	0.93206	0.2755
03-Nov-07	0.95660	0.95924	0.2755
04-Nov-07	1.04250	1.04537	0.2755
05-Nov-07	1.11080	1.11386	0.2755
06-Nov-07	1.11820	1.12128	0.2755
07-Nov-07	1.03080	1.03364	0.2755
08-Nov-07	1.11200	1.11506	0.2755
09-Nov-07	1.27100	1.27450	0.2755
10-Nov-07	1.10890	1.11196	0.2755
11-Nov-07	1.15430	1.15748	0.2755
12-Nov-07	1.44040	1.44437	0.2755
13-Nov-07	1.30720	1.31080	0.2755
14-Nov-07	1.31600	1.31963	0.2755
15-Nov-07	1.31180	1.31541	0.2755
16-Nov-07	1.39400	1.39784	0.2755
17-Nov-07	1.22511	1.22849	0.2755
18-Nov-07	1.38290	1.38671	0.2755
19-Nov-07	1.41480	1.41870	0.2755
20-Nov-07	1.29890	1.30248	0.2755
21-Nov-07	1.19200	1.19528	0.2755

22-Nov-07	1.23820	1.24161	0.2755
23-Nov-07	1.56220	1.56650	0.2755
24-Nov-07	1.42040	1.42431	0.2755
25-Nov-07	1.26070	1.26417	0.2755
26-Nov-07	1.26670	1.27019	0.2755
27-Nov-07	1.17170	1.17493	0.2755
28-Nov-07	1.23320	1.23660	0.2755
29-Nov-07	1.24490	1.24833	0.2755
30-Nov-07	1.17980	1.18305	0.2755
01-Dec-07	1.24590	1.24933	0.2755
02-Dec-07	1.26140	1.26488	0.2755
03-Dec-07	1.32370	1.32735	0.2755
04-Dec-07	1.24740	1.25084	0.2755
05-Dec-07	1.13480	1.13793	0.2755
06-Dec-07	1.11740	1.12048	0.2755
07-Dec-07	1.27360	1.27711	0.2755
08-Dec-07	1.37790	1.38170	0.2755
09-Dec-07	1.29900	1.30258	0.2755
10-Dec-07	1.40330	1.40717	0.2755
11-Dec-07	1.51780	1.52198	0.2755
12-Dec-07	1.39810	1.40195	0.2755
13-Dec-07	1.46040	1.46442	0.2755
14-Dec-07	1.59450	1.59889	0.2755
15-Dec-07	1.48800	1.49210	0.2755
16-Dec-07	1.55370	1.55798	0.2755
17-Dec-07	1.55410	1.55838	0.2755
18-Dec-07	1.55240	1.55668	0.2755
19-Dec-07	1.46060	1.46462	0.2755
20-Dec-07	1.62620	1.63068	0.2755
21-Dec-07	1.68120	1.68583	0.2755
22-Dec-07	1.49730	1.50143	0.2755
23-Dec-07	1.42660	1.43053	0.2755
24-Dec-07	1.25030	1.25374	0.2755
25-Dec-07	1.15050	1.15367	0.2755
26-Dec-07	1.20960	1.21293	0.2755
27-Dec-07	1.09620	1.09922	0.2755
28-Dec-07	1.10550	1.10855	0.2755
29-Dec-07	1.23430	1.23770	0.2755
30-Dec-07	1.11820	1.12128	0.2755
31-Dec-07	1.14700	1.15016	0.2755
01-Jan-08	1.02220	1.02502	0.2755
02-Jan-08	1.37980	1.38360	0.2755
03-Jan-08	1.60690	1.61133	0.2755
04-Jan-08	1.40580	1.40967	0.2755
05-Jan-08	1.35190	1.35562	0.2755
06-Jan-08	1.35690	1.36064	0.2755
07-Jan-08	1.42290	1.42682	0.2755
08-Jan-08	1.42020	1.42411	0.2755

09-Jan-08	1.42790	1.43183	0.2755
10-Jan-08	1.32340	1.32705	0.2755
11-Jan-08	1.46800	1.47204	0.2755
12-Jan-08	1.39890	1.40275	0.2755
13-Jan-08	1.28540	1.28894	0.2755
14-Jan-08	1.31760	1.32123	0.2755
15-Jan-08	1.32190	1.32554	0.2755
16-Jan-08	1.33390	1.33757	0.2755
17-Jan-08	1.37520	1.37899	0.2755
18-Jan-08	1.20620	1.20952	0.2755
19-Jan-08	1.16340	1.16661	0.2755
20-Jan-08	1.08701	1.09000	0.2755
21-Jan-08	1.20239	1.20570	0.2755
22-Jan-08	1.42310	1.42702	0.2755
23-Jan-08	1.20890	1.21223	0.2755
24-Jan-08	1.26020	1.26367	0.2755
25-Jan-08	1.32240	1.32604	0.2755
26-Jan-08	1.25179	1.25524	0.2755
27-Jan-08	1.25190	1.25535	0.2755
28-Jan-08	1.31290	1.31652	0.2755
29-Jan-08	1.28830	1.29185	0.2755
30-Jan-08	1.40830	1.41218	0.2755
31-Jan-08	1.51559	1.51977	0.2755
01-Feb-08	1.64190	1.64642	0.2755
02-Feb-08	1.56940	1.57372	0.2755
03-Feb-08	1.45110	1.45510	0.2755
04-Feb-08	1.42110	1.42502	0.2755
05-Feb-08	1.37010	1.37387	0.2755
06-Feb-08	1.23810	1.24151	0.2755
07-Feb-08	1.24890	1.25234	0.2755
08-Feb-08	1.21130	1.21464	0.2755
09-Feb-08	1.23160	1.23499	0.2755
10-Feb-08	1.22130	1.22466	0.2755
11-Feb-08	1.30500	1.30860	0.2755
12-Feb-08	1.19180	1.19508	0.2755
13-Feb-08	1.29160	1.29516	0.2755
14-Feb-08	1.33260	1.33627	0.2755
15-Feb-08	1.42000	1.42391	0.2755
16-Feb-08	1.50150	1.50564	0.2755
17-Feb-08	1.63460	1.63910	0.2755
18-Feb-08	1.62300	1.62747	0.2755
19-Feb-08	1.42720	1.43113	0.2755
20-Feb-08	1.50590	1.51005	0.2755
21-Feb-08	1.30170	1.30529	0.2755
22-Feb-08	1.21650	1.21985	0.2755
23-Feb-08	1.22900	1.23239	0.2755
24-Feb-08	1.25120	1.25465	0.2755
25-Feb-08	1.36200	1.36575	0.2755

26-Feb-08	1.21840	1.22176	0.2755
27-Feb-08	1.23150	1.23489	0.2755
28-Feb-08	1.25000	1.25344	0.2755
29-Feb-08	1.31740	1.32103	0.2755
01-Mar-08	1.22490	1.22827	0.2755
02-Mar-08	1.16770	1.17092	0.2755
03-Mar-08	1.41390	1.41780	0.2755
04-Mar-08	1.40530	1.40917	0.2755
05-Mar-08	1.35370	1.35743	0.2755
06-Mar-08	1.23940	1.24281	0.2755
07-Mar-08	1.17590	1.17914	0.2755
08-Mar-08	1.17510	1.17834	0.2755
09-Mar-08	1.14400	1.14715	0.2755
10-Mar-08	1.26870	1.27220	0.2755
11-Mar-08	1.17860	1.18185	0.2755
12-Mar-08	1.27680	1.28032	0.2755
13-Mar-08	1.23660	1.24001	0.2755
14-Mar-08	1.14970	1.15287	0.2755
15-Mar-08	1.07860	1.08157	0.2755
16-Mar-08	1.18500	1.18826	0.2755
17-Mar-08	1.30460	1.30819	0.2755
18-Mar-08	1.24960	1.25304	0.2755
19-Mar-08	1.11260	1.11567	0.2755
20-Mar-08	1.22890	1.23229	0.2755
21-Mar-08	1.28130	1.28483	0.2755
22-Mar-08	1.32720	1.33086	0.2755
23-Mar-08	1.32500	1.32865	0.2755
24-Mar-08	1.28630	1.28984	0.2755
25-Mar-08	1.32590	1.32955	0.2755
26-Mar-08	1.17690	1.18014	0.2755
27-Mar-08	1.17740	1.18064	0.2755
28-Mar-08	1.24430	1.24773	0.2755
29-Mar-08	1.12310	1.12619	0.2755
30-Mar-08	1.00620	1.00897	0.2755
31-Mar-08	1.05600	1.05891	0.2755
01-Apr-08	1.07110	1.07405	0.2755
02-Apr-08	0.98320	0.98591	0.2755
03-Apr-08	0.96270	0.96535	0.2755
04-Apr-08	0.91130	0.91381	0.2755
05-Apr-08	1.09040	1.09340	0.2755
06-Apr-08	1.28960	1.29315	0.2755
07-Apr-08	1.32270	1.32634	0.2755
08-Apr-08	1.29610	1.29967	0.2755
09-Apr-08	1.22601	1.22939	0.2755
10-Apr-08	1.15630	1.15949	0.2755
11-Apr-08	1.17700	1.18024	0.2755
12-Apr-08	1.13200	1.13512	0.2755
13-Apr-08	1.08540	1.08839	0.2755

14-Apr-08	1.12040	1.12349	0.2755
15-Apr-08	1.14800	1.15116	0.2755
16-Apr-08	1.12960	1.13271	0.2755
17-Apr-08	1.13879	1.14193	0.2755
18-Apr-08	1.27890	1.28242	0.2755
19-Apr-08	1.21910	1.22246	0.2755
20-Apr-08	1.15500	1.15818	0.2755
21-Apr-08	1.00810	1.01088	0.2755
22-Apr-08	0.90730	0.90980	0.2755
23-Apr-08	0.77430	0.77643	0.2755
24-Apr-08	0.91660	0.91913	0.2755
25-Apr-08	0.93980	0.94239	0.2755
26-Apr-08	0.76340	0.76550	0.2755
27-Apr-08	0.69810	0.70002	0.2755
28-Apr-08	0.88360	0.88603	0.2755
29-Apr-08	0.87010	0.87250	0.2755
30-Apr-08	0.81310	0.81534	0.2755
01-May-08	0.83850	0.84081	0.2755
02-May-08	0.78310	0.78526	0.2755
03-May-08	0.66530	0.66713	0.2755
04-May-08	0.60020	0.60185	0.2755
05-May-08	0.54040	0.54189	0.2755
06-May-08	0.53380	0.53527	0.2755
07-May-08	0.44260	0.44382	0.2755
08-May-08	0.53080	0.53226	0.2755
09-May-08	0.51440	0.51582	0.2755
10-May-08	0.45670	0.45796	0.2755
11-May-08	0.50010	0.50148	0.2755
12-May-08	0.48590	0.48724	0.2755
13-May-08	0.52580	0.52725	0.2755
14-May-08	0.47140	0.47270	0.2755
15-May-08	0.54360	0.54510	0.2755
16-May-08	0.63970	0.64146	0.2755
17-May-08	0.75570	0.75778	0.2755
18-May-08	0.67040	0.67225	0.2755
19-May-08	0.68820	0.69010	0.2755
20-May-08	0.68160	0.68348	0.2755
21-May-08	0.64070	0.64247	0.2755
22-May-08	0.59020	0.59183	0.2755
23-May-08	0.58270	0.58431	0.2755
24-May-08	0.50370	0.50509	0.2755
25-May-08	0.67060	0.67245	0.2755
26-May-08	0.66300	0.66483	0.2755
27-May-08	0.70760	0.70955	0.2755
28-May-08	0.65540	0.65721	0.2755
29-May-08	0.61570	0.61740	0.2755
30-May-08	0.60640	0.60807	0.2755
31-May-08	0.55280	0.55432	0.2755

01-Jun-08	0.62950	0.63123	0.2755
02-Jun-08	0.59200	0.59363	0.2755
03-Jun-08	0.65450	0.65630	0.2755
04-Jun-08	0.51910	0.52053	0.2755
05-Jun-08	0.56700	0.56856	0.2755
06-Jun-08	0.58230	0.58390	0.2755
07-Jun-08	0.59270	0.59433	0.2755
08-Jun-08	0.54400	0.54550	0.2755
09-Jun-08	0.56640	0.56796	0.2755
10-Jun-08	0.50580	0.50719	0.2755
11-Jun-08	0.55020	0.55172	0.2755
12-Jun-08	0.60300	0.60466	0.2755
13-Jun-08	0.64520	0.64698	0.2755
14-Jun-08	0.57090	0.57247	0.2755
15-Jun-08	0.62050	0.62221	0.2755
16-Jun-08	0.54880	0.55031	0.2755
17-Jun-08	0.62090	0.62261	0.2755
18-Jun-08	0.65510	0.65690	0.2755
19-Jun-08	0.58070	0.58230	0.2755
20-Jun-08	0.56550	0.56706	0.2755
21-Jun-08	0.64250	0.64427	0.2755
22-Jun-08	0.61860	0.62030	0.2755
23-Jun-08	0.62660	0.62833	0.2755
24-Jun-08	0.58670	0.58832	0.2755
25-Jun-08	0.53240	0.53387	0.2755
26-Jun-08	0.63940	0.64116	0.2755
27-Jun-08	0.60840	0.61008	0.2755
28-Jun-08	0.56650	0.56806	0.2755
29-Jun-08	0.58040	0.58200	0.2755
30-Jun-08	0.57620	0.57779	0.2755
01-Jul-08	0.53220	0.53367	0.2755
02-Jul-08	0.47850	0.47982	0.2755
03-Jul-08	0.51730	0.51873	0.2755
04-Jul-08	0.51100	0.51241	0.2755
05-Jul-08	0.48330	0.48463	0.2755
06-Jul-08	0.48910	0.49045	0.2755
07-Jul-08	0.62770	0.62818	0.0758