



ASSESSMENT OF ERROR DUE TO ORIFICE DIAMETER MIS-MEASUREMENT AT CALDECOTT

A Report for

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

PROJECT NO: NGR010

REPORT NO: 2010_228

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

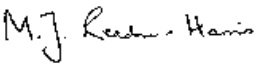
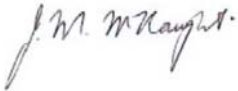
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National Grid
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LE10 0NA

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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 Caldecott a correction factor of 1.002310 should be applied during the period of mis-measurement.

Over the period 27/06/2007 to 24/04/2008 inclusive the flow was 115.41910 mscm and the corrected flow should be 115.68487 mscm.

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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 Caldecott in the period of the error. The Joint Office Error Code is EM003.

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 (°C)	Value at 20 °C
					Orifice Bore (mm)
OP50101	286-9	11/07/2005	117.2545	21	117.2526
OP70054	Cald-1-1	06/06/2007	117.1515	21	117.1496
OP80011	286-9	07/04/2008	117.2595	20	117.2595
OP80031	Cald-1-1	23/06/2008	117.2810	20	117.2810
OP90017	286-9	28/05/2009	117.2575	21	117.2556

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

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

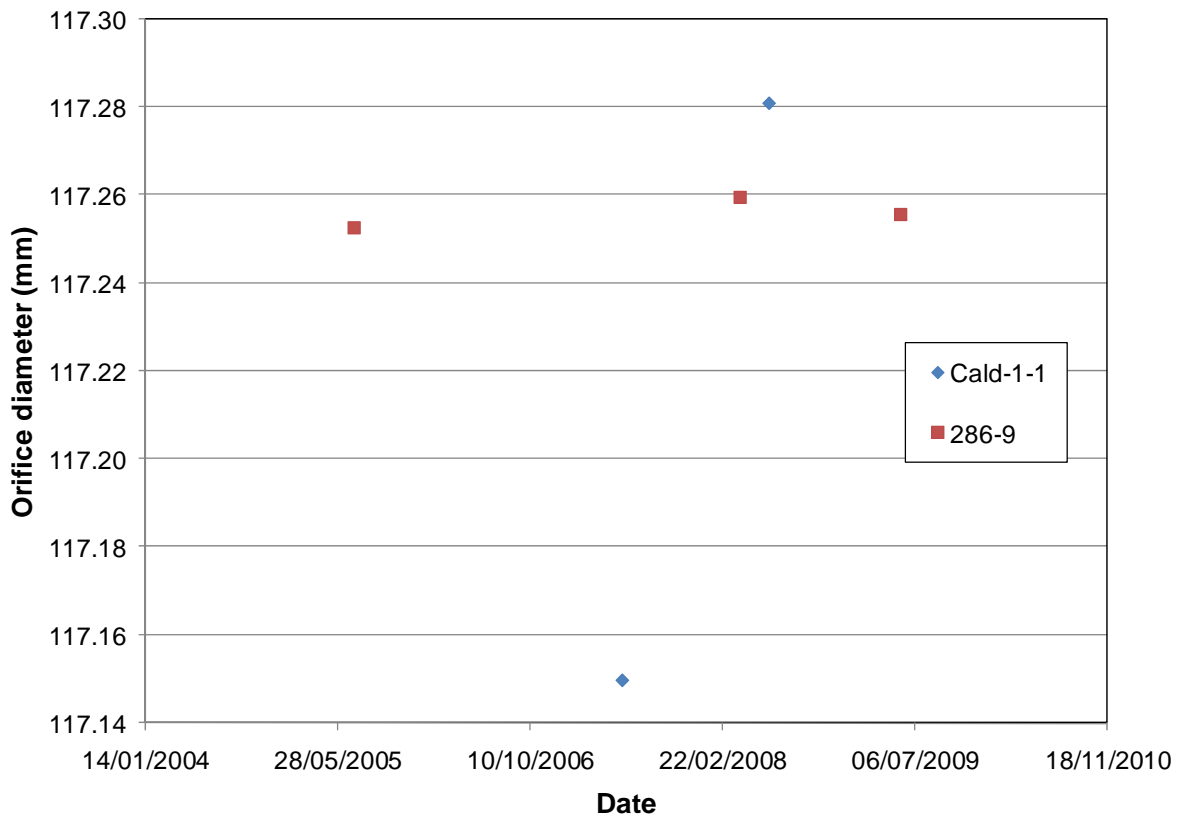


Figure 1 Orifice Diameters at 20 °C

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	omnM0602.cfg	omnM0627.cfg	omnN0417.cfg	omnN0422.cfg	omnN0424.cfg
	02/06/2007 23:01	27/06/2007 23:01	17/04/2008 23:01	22/04/2008 23:01	24/04/2008 23:01
Orifice plate bore diameter (mm)	117.2545	117.1515	117.1515	117.1515	117.2595
Expansion coefficient of the plate (1/°C)	0.000016	0.000016	0.000016	0.000016	0.000016
Orifice plate calibration temperature	21	21	21	21	20
Meter tube diameter (mm)	304.872	304.872	304.872	304.872	304.872
Expansion coefficient of the meter tube (1/°C)	0.000011	0.000011	0.000011	0.000011	0.000011
Meter tube calibration temperature	20	20	20	20	20
Iisentropic Exponent	1.3556	1.3556	1.3563	1.3563	1.3563
Dynamic Viscosity (Pa.s)	0.0000122	0.0000122	0.0000122	0.0000124	0.0000124
Orifice plate certificate number	OP50101	OP70054	OP70054	OP70054	OP80011
Orifice plate serial number	286-9	cald-1-1	cald-1-1	cald-1-1	286-9
Error in orifice diameter?	No	Yes	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:

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

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 47 bar a; the change in $q_{m,c}/q_{m,o}$ due to changing the static pressure by 10 bar is around 0.00001% at maximum.

Over the period from 27/06/2007 to 17/04/2008 the correction can be calculated as in Table 3; throughout this calculation the meter tube diameter is 304.872 mm, the isentropic exponent is 1.3556 and the dynamic viscosity 0.0000122 Pa s.

TABLE 3
THE CORRECTION FROM 27/06/2007 TO 17/04/2008

	d mm	β	ε	Re_D	C	$\frac{q_{m,c}}{q_{m,o}}$
Original: $\Delta p=10$ mbar	117.1496	0.384258	0.999934	635616	0.600380	
Corrected $\Delta p=10$ mbar	117.281	0.384689	0.999934	637084	0.600390	1.0023105
Original $\Delta p=500$ mbar	117.1496	0.384258	0.996723	4477905	0.600093	
Corrected $\Delta p=500$ mbar	117.281	0.384689	0.996722	4488247	0.600103	1.0023097

So $q_{m,c}/q_{m,o}$ is 1.002310.

Over the period from 17/04/2008 to 22/04/2008 the correction can be calculated as in Table 4; throughout this calculation the meter tube diameter is 304.872 mm, the isentropic exponent is 1.3563 and the dynamic viscosity 0.0000122 Pa s.

TABLE 4
THE CORRECTION FROM 17/04/2008 TO 22/04/2008

	d mm	β	ε	Re_D	C	$\frac{q_{m,c}}{q_{m,o}}$
Original: $\Delta p=10$ mbar	117.1496	0.384258	0.999934	625369	0.600384	
Corrected $\Delta p=10$ mbar	117.281	0.384689	0.999934	626814	0.600394	1.0023105
Original $\Delta p=500$ mbar	117.1496	0.384258	0.996724	4405696	0.600094	
Corrected $\Delta p=500$ mbar	117.281	0.384689	0.996724	4415872	0.600104	1.0023097

So $q_{m,c}/q_{m,o}$ is 1.002310.

Over the period from 22/04/2008 to 24/04/2008 the correction can be calculated as in Table 5; throughout this calculation the meter tube diameter is 304.872 mm, the isentropic exponent is 1.3563 and the dynamic viscosity 0.0000124 Pa s.

TABLE 5

THE CORRECTION FROM 22/04/2008 TO 24/04/2008

	d mm	β	ε	Re_D	C	$\frac{q_{m,c}}{q_{m,o}}$
Original: $\Delta p=10$ mbar	117.1496	0.384258	0.999934	625369	0.600384	
Corrected $\Delta p=10$ mbar	117.281	0.384689	0.999934	626814	0.600394	1.0023105
Original $\Delta p=500$ mbar	117.1496	0.384258	0.996724	4405696	0.600094	
Corrected $\Delta p=500$ mbar	117.281	0.384689	0.996724	4415872	0.600104	1.0023097

So $q_{m,c}/q_{m,o}$ is 1.002310.

4 CORRECTIONS ON A DAILY BASIS

The volume flows for each day from 27/06/2007 to 24/04/2008 are given in Table B.1 of Appendix B together with the corrected values. It has been assumed that the plates were changed at 09:30; therefore the whole flow for 27/06/2007 has to be corrected and 15.0% of the flow 24/04/2008 should be corrected based on the total flow measured before 09:30 (the differential pressure appears to be in error). Summing the data gives the figures in Table 6.

TABLE 6

THE FLOW OVER THE PERIOD 27/06/2007 TO 24/04/2008 INCLUSIVE

Flow (mscm)	115.41910
Correction (mscm)	0.26576
Corrected flow (mscm)	115.68486
% change	0.2303

5 CONCLUSIONS

A correction factor of 1.002310 should be applied during the period of mis-measurement.

APPENDIX A
ORIFICE PLATE CALIBRATION CERTIFICATES

TRANSCO ORIFICE PLATE CALIBRATION

DATE: 11-07-05
REF NO: OP50101
TEMPERATURE: 21 degsC

MEASURED ORIFICE BORE: 117.2545mm

PLATE DETAILS

PLATE SERIAL.	286-9	PLATE O.D	319.727mm		
MANUFACTURER:		PIPE I.D:	mm	SITE	CALDICOTE
MATERIAL CERT.No	373901	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

FLATNESS %	0.178	0.348	0.381	0.171	0.184	0.384	0.346	0.159
E mm	6.572	6.541	6.512	6.530	6.562		6.566	6.570
mm	4.930	4.89	4.833	4.804	4.83	4.892	4.928	4.920
EDGE SHARPNESS mm	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125
BEVEL ANGLE	37 DEGS							
CONCENTRICITY	0.028mm							
SURFACE FINISH (Ra)	1.6 microns							
DOWNSTREAM FACE/EDGE VISUAL INSPECTION	PASS							
ROUNDNESS	0.011mm	TAPER						

COMMENTS

INSPECTED BY



G. WARDLE

VERIFIED BY



P. KENNERSON

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 06-06-07
 REF NO: OP70054
 TEMPERATURE: 21 degsC

MEASURED ORIFICE BORE: 117.1515mm

PLATE DETAILS

PLATE SERIAL: CALD-1-1 PLATE O.D: 319.701mm
 MANUFACTURER: PIPE I.D: mm SITE: CALDICOTE
 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 %	0.119	0.046	0.038	0.082	0.080	0.037	0.045	0.094
IR mm	6.719	6.636	6.637	6.733	6.736	6.650	6.654	6.728
'e' mm	4.721	4.668	4.658	4.729	4.719	4.654	4.663	4.715
EDGE SHARPNESS mm	0.025	0.0125	0.0125	0.0125	0.0125	SQ	0.0125	0.0125
BEVEL ANGLE:	44 DEGS							
CONCENTRICITY:	0.068mm							
SURFACE FINISH (Ra)	1.1 microns							
DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS								
ROUNDNESS	0.100mm	TAPER	0 degs					

COMMENTS:

INSPECTED BY..

 P. KENNERSON  J. CHAUDHAN

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 07-APRIL-2008
 REF NO: OP80011
 TEMPERATURE: 20 degsC

MEASURED ORIFICE BORE: 117.2595mm

PLATE DETAILS

PLATE SERIAL: 286-9 PLATE O.D: 319.724mm
 MANUFACTURER: PIPE I.D: mm SITE: CALDICOTT
 MATERIAL CERT.No: DESIGN BORE: mm FLOW: M³/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	2	4	5	6	8			
FLATNESS	0.030	0.023	0.005	0.011	0.035	0.009	0.005	
	5.832	5.832	5.845	5.843	5.84	5.848	5.839	5.831
	.649	4.614	4.454	4.581	4.667	4.746	4.702	4.665
EDGE SHARPNESS mm	SQUARE	SQUARE	0.0125	0.0125	0.0125	0.0125	0.0125	
BEVEL ANGLE	37 DEGS							
CONCENTRICITY	0.027mm							
SURFACE FINISH (Ra)	0.8 microns							
DOWNSTREAM FACE/EDGE VISUAL INSPECTION	PASS							
ROUNDNESS	0.012mm	TAPER	0 degs					

COMMENTS

INSPECTED BY:  M Livingst

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 23-JUNE-2008
 REF NO: OP80031
 TEMPERATURE: 20 degsC

MEASURED ORIFICE BORE: 117.281mm

PLATE DETAILS

PLATE SERIAL. CALD-1-1 PLATE O.D 319.960mm
 MANUFACTURER: PIPE I.D: mm SITE CALDICOTT
 MATERIAL CERT.No DESIGN BORE mm FLOW M³/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 μ	0.145	0.084	0.061	0.097	0.098	0.066	0.036	0.102
'E' mm	6.666	6.651	6.657	6.671	6.669	6.666	6.671	5.773
'e' mm	4.688	4.676	4.668	4.679	4.686	4.675	4.674	4.681
EDGE SHARPNESS mm	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.0125
BEVEL ANGLE	44 DEGS							
CONCENTRICITY	0.092mm							
SURFACE FINISH (Ra)	1.1 microns							
DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS								
ROUNDNESS	0.007mm	TAPER: 0 degs						

DRAINHOLE PRESENT ? (YES/NO): No

COMMENTS: CLEAN PLATE.

INSPECTED BY:  M Livingstone

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 28-MAY-2009

REF NO: OP90017

TEMPERATURE: 20.7 degsC

MEASURED ORIFICE BORE: 117.2575mm

PLATE DETAILS

PLATE SERIAL.	286-9	PLATE O.D		SITE	CALDICOTT
MANUFACTURER:	ANT	PIPE I.D:	304.872mm	FLOW	M ³ /DAY
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, UKAS CERT:- 6822. NEXT CAL DUE:- 03-OCTOBER-2009

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS:	1	2	4	5	8			
FLATNESS %	0.052	0.031	0.010	0.022	0.054	0.027	0.021	0.011
			5.841	5.840	5.832	5.846	5.828	5.366
	4.647	4.575	4.463	4.568	4.690	4.713	4.680	4.260
EDGE SHARPNESS mm	SQUARE	SQUARE	SQUARE	0.0125	0.0125	0.0125	SQUARE	SQUARE
BEVEL ANGLE	37 DEGS							
CONCENTRICITY	0.028mm							
SURFACE FINISH (Ra)	0.77 microns							

DOWNSTREAM FACE/EDGE VISUAL INSPECTION: PASS

ROUNDNESS 0.009mm TAPER 0 degs

DRAINHOLE PRESENT (YES/NO): No

COMMENTS: CLEAN PLATE

INSPECTED BY:  M Livingstone

APPENDIX B
CORRECTED DAILY VOLUME FLOWS

TABLE B.1

FLOWS AT CALDECOTT DURING THE PERIOD OF THE MIS-MEASUREMENT

	Original Values (total)	Corrected values (total)	% increase
Date	Volume (mscm)	Volume (mscm)	Volume (mscm)
27-Jun-07	0.0000	0.00000	0.0000
28-Jun-07	0.0000	0.00000	0.0000
29-Jun-07	0.1192	0.11948	0.2310
30-Jun-07	0.0000	0.00000	0.0000
01-Jul-07	0.0000	0.00000	0.0000
02-Jul-07	0.0000	0.00000	0.0000
03-Jul-07	0.0000	0.00000	0.0000
04-Jul-07	0.0000	0.00000	0.0000
05-Jul-07	0.0000	0.00000	0.0000
06-Jul-07	0.0020	0.00200	0.2310
07-Jul-07	0.0000	0.00000	0.0000
08-Jul-07	0.0000	0.00000	0.0000
09-Jul-07	0.0000	0.00000	0.0000
10-Jul-07	0.0000	0.00000	0.0000
11-Jul-07	0.0000	0.00000	0.0000
12-Jul-07	0.0000	0.00000	0.0000
13-Jul-07	0.0000	0.00000	0.0000
14-Jul-07	0.0000	0.00000	0.0000
15-Jul-07	0.0000	0.00000	0.0000
16-Jul-07	0.0000	0.00000	0.0000
17-Jul-07	0.0000	0.00000	0.0000
18-Jul-07	0.0000	0.00000	0.0000
19-Jul-07	0.0000	0.00000	0.0000
20-Jul-07	0.0221	0.02215	0.2310
21-Jul-07	0.0527	0.05282	0.2310
22-Jul-07	0.0000	0.00000	0.0000
23-Jul-07	0.0000	0.00000	0.0000
24-Jul-07	0.0573	0.05743	0.2310
25-Jul-07	0.0000	0.00000	0.0000
26-Jul-07	0.0000	0.00000	0.0000
27-Jul-07	0.0000	0.00000	0.0000
28-Jul-07	0.0000	0.00000	0.0000
29-Jul-07	0.0000	0.00000	0.0000
30-Jul-07	0.0000	0.00000	0.0000
31-Jul-07	0.0075	0.00752	0.2310
01-Aug-07	0.0000	0.00000	0.0000
02-Aug-07	0.0000	0.00000	0.0000
03-Aug-07	0.0000	0.00000	0.0000
04-Aug-07	0.0000	0.00000	0.0000

05-Aug-07	0.0000	0.00000	0.0000
06-Aug-07	0.0000	0.00000	0.0000
07-Aug-07	0.0000	0.00000	0.0000
08-Aug-07	0.0000	0.00000	0.0000
09-Aug-07	0.0000	0.00000	0.0000
10-Aug-07	0.0000	0.00000	0.0000
11-Aug-07	0.0000	0.00000	0.0000
12-Aug-07	0.0000	0.00000	0.0000
13-Aug-07	0.0000	0.00000	0.0000
14-Aug-07	0.0000	0.00000	0.0000
15-Aug-07	0.0000	0.00000	0.0000
16-Aug-07	0.0000	0.00000	0.0000
17-Aug-07	0.0000	0.00000	0.0000
18-Aug-07	0.0000	0.00000	0.0000
19-Aug-07	0.0000	0.00000	0.0000
20-Aug-07	0.0000	0.00000	0.0000
21-Aug-07	0.0503	0.05042	0.2310
22-Aug-07	0.0000	0.00000	0.0000
23-Aug-07	0.0000	0.00000	0.0000
24-Aug-07	0.0000	0.00000	0.0000
25-Aug-07	0.0000	0.00000	0.0000
26-Aug-07	0.0000	0.00000	0.0000
27-Aug-07	0.0000	0.00000	0.0000
28-Aug-07	0.0000	0.00000	0.0000
29-Aug-07	0.0054	0.00541	0.2310
30-Aug-07	0.0000	0.00000	0.0000
31-Aug-07	0.0000	0.00000	0.0000
01-Sep-07	0.0000	0.00000	0.0000
02-Sep-07	0.0000	0.00000	0.0000
03-Sep-07	0.0000	0.00000	0.0000
04-Sep-07	0.0000	0.00000	0.0000
05-Sep-07	0.0000	0.00000	0.0000
06-Sep-07	0.0000	0.00000	0.0000
07-Sep-07	0.0000	0.00000	0.0000
08-Sep-07	0.0000	0.00000	0.0000
09-Sep-07	0.0000	0.00000	0.0000
10-Sep-07	0.0000	0.00000	0.0000
11-Sep-07	0.0000	0.00000	0.0000
12-Sep-07	0.0000	0.00000	0.0000
13-Sep-07	0.0000	0.00000	0.0000
14-Sep-07	0.0000	0.00000	0.0000
15-Sep-07	0.0000	0.00000	0.0000
16-Sep-07	0.0000	0.00000	0.0000
17-Sep-07	0.0000	0.00000	0.0000
18-Sep-07	0.1423	0.14263	0.2310
19-Sep-07	0.0000	0.00000	0.0000
20-Sep-07	0.0000	0.00000	0.0000
21-Sep-07	0.0000	0.00000	0.0000

22-Sep-07	0.0000	0.00000	0.0000
23-Sep-07	0.0000	0.00000	0.0000
24-Sep-07	0.0000	0.00000	0.0000
25-Sep-07	0.0000	0.00000	0.0000
26-Sep-07	0.0450	0.04510	0.2310
27-Sep-07	0.0607	0.06084	0.2310
28-Sep-07	0.0117	0.01173	0.2310
29-Sep-07	0.0000	0.00000	0.0000
30-Sep-07	0.0000	0.00000	0.0000
01-Oct-07	0.0000	0.00000	0.0000
02-Oct-07	0.0000	0.00000	0.0000
03-Oct-07	0.0293	0.02937	0.2310
04-Oct-07	0.0000	0.00000	0.0000
05-Oct-07	0.0000	0.00000	0.0000
06-Oct-07	0.0000	0.00000	0.0000
07-Oct-07	0.0000	0.00000	0.0000
08-Oct-07	0.0000	0.00000	0.0000
09-Oct-07	0.0000	0.00000	0.0000
10-Oct-07	0.0000	0.00000	0.0000
11-Oct-07	0.0000	0.00000	0.0000
12-Oct-07	0.0000	0.00000	0.0000
13-Oct-07	0.0000	0.00000	0.0000
14-Oct-07	0.0000	0.00000	0.0000
15-Oct-07	0.0000	0.00000	0.0000
16-Oct-07	0.0000	0.00000	0.0000
17-Oct-07	0.0000	0.00000	0.0000
18-Oct-07	0.0000	0.00000	0.0000
19-Oct-07	0.0000	0.00000	0.0000
20-Oct-07	0.0000	0.00000	0.0000
21-Oct-07	0.0000	0.00000	0.0000
22-Oct-07	0.2356	0.23614	0.2310
23-Oct-07	0.4624	0.46347	0.2310
24-Oct-07	0.3862	0.38709	0.2310
25-Oct-07	0.3553	0.35612	0.2310
26-Oct-07	0.3697	0.37055	0.2310
27-Oct-07	0.3852	0.38609	0.2310
28-Oct-07	0.3788	0.37968	0.2310
29-Oct-07	0.4977	0.49885	0.2310
30-Oct-07	0.4986	0.49975	0.2310
31-Oct-07	0.4986	0.49975	0.2310
01-Nov-07	0.3292	0.32996	0.2310
02-Nov-07	0.2988	0.29949	0.2310
03-Nov-07	0.2983	0.29899	0.2310
04-Nov-07	0.4384	0.43941	0.2310
05-Nov-07	0.4991	0.50025	0.2310
06-Nov-07	0.4907	0.49183	0.2310
07-Nov-07	0.2091	0.20958	0.2310
08-Nov-07	0.5761	0.57743	0.2310

09-Nov-07	0.5834	0.58475	0.2310
10-Nov-07	0.3268	0.32755	0.2310
11-Nov-07	0.3383	0.33908	0.2310
12-Nov-07	0.4974	0.49855	0.2310
13-Nov-07	0.4986	0.49975	0.2310
14-Nov-07	0.5004	0.50156	0.2310
15-Nov-07	0.4985	0.49965	0.2310
16-Nov-07	0.5000	0.50116	0.2310
17-Nov-07	0.4834	0.48452	0.2310
18-Nov-07	0.6752	0.67676	0.2310
19-Nov-07	0.5731	0.57442	0.2310
20-Nov-07	0.6246	0.62604	0.2310
21-Nov-07	0.6869	0.68849	0.2310
22-Nov-07	0.7912	0.79303	0.2310
23-Nov-07	0.9441	0.94628	0.2310
24-Nov-07	0.9538	0.95600	0.2310
25-Nov-07	0.9532	0.95540	0.2310
26-Nov-07	0.8067	0.80856	0.2310
27-Nov-07	0.7605	0.76226	0.2310
28-Nov-07	0.6500	0.65150	0.2310
29-Nov-07	0.6532	0.65471	0.2310
30-Nov-07	0.6529	0.65441	0.2310
01-Dec-07	0.6498	0.65130	0.2310
02-Dec-07	0.6163	0.61772	0.2310
03-Dec-07	0.6702	0.67175	0.2310
04-Dec-07	0.7111	0.71274	0.2310
05-Dec-07	0.4489	0.44994	0.2310
06-Dec-07	0.4433	0.44432	0.2310
07-Dec-07	0.7631	0.76486	0.2310
08-Dec-07	0.5363	0.53754	0.2310
09-Dec-07	0.6876	0.68919	0.2310
10-Dec-07	0.7575	0.75925	0.2310
11-Dec-07	0.7315	0.73319	0.2310
12-Dec-07	0.6730	0.67455	0.2310
13-Dec-07	0.8363	0.83823	0.2310
14-Dec-07	0.7583	0.76005	0.2310
15-Dec-07	0.7409	0.74261	0.2310
16-Dec-07	0.7151	0.71675	0.2310
17-Dec-07	0.8558	0.85778	0.2310
18-Dec-07	0.6948	0.69640	0.2310
19-Dec-07	0.6656	0.66714	0.2310
20-Dec-07	0.7827	0.78451	0.2310
21-Dec-07	0.7219	0.72357	0.2310
22-Dec-07	0.5518	0.55307	0.2310
23-Dec-07	0.5435	0.54476	0.2310
24-Dec-07	0.6000	0.60139	0.2310
25-Dec-07	0.6684	0.66994	0.2310
26-Dec-07	0.6952	0.69681	0.2310

27-Dec-07	0.7015	0.70312	0.2310
28-Dec-07	0.6994	0.70102	0.2310
29-Dec-07	0.6993	0.70092	0.2310
30-Dec-07	0.7006	0.70222	0.2310
31-Dec-07	0.6413	0.64278	0.2310
01-Jan-08	0.4989	0.50005	0.2310
02-Jan-08	0.4975	0.49865	0.2310
03-Jan-08	0.4982	0.49935	0.2310
04-Jan-08	0.4995	0.50065	0.2310
05-Jan-08	0.4985	0.49965	0.2310
06-Jan-08	0.4992	0.50035	0.2310
07-Jan-08	0.5496	0.55087	0.2310
08-Jan-08	0.7540	0.75574	0.2310
09-Jan-08	0.8426	0.84455	0.2310
10-Jan-08	0.8338	0.83573	0.2310
11-Jan-08	0.8331	0.83502	0.2310
12-Jan-08	0.8318	0.83372	0.2310
13-Jan-08	0.6708	0.67235	0.2310
14-Jan-08	0.6741	0.67566	0.2310
15-Jan-08	0.6512	0.65270	0.2310
16-Jan-08	0.7405	0.74221	0.2310
17-Jan-08	0.9056	0.90769	0.2310
18-Jan-08	0.8047	0.80656	0.2310
19-Jan-08	0.4800	0.48111	0.2310
20-Jan-08	0.3990	0.39992	0.2310
21-Jan-08	0.5750	0.57633	0.2310
22-Jan-08	0.5458	0.54706	0.2310
23-Jan-08	0.5926	0.59397	0.2310
24-Jan-08	0.7255	0.72718	0.2310
25-Jan-08	0.7152	0.71685	0.2310
26-Jan-08	0.6482	0.64970	0.2310
27-Jan-08	0.6759	0.67746	0.2310
28-Jan-08	1.0016	1.00391	0.2310
29-Jan-08	0.7887	0.79052	0.2310
30-Jan-08	0.7869	0.78872	0.2310
31-Jan-08	0.7652	0.76697	0.2310
01-Feb-08	0.6283	0.62975	0.2310
02-Feb-08	0.4056	0.40654	0.2310
03-Feb-08	0.4701	0.47119	0.2310
04-Feb-08	0.9868	0.98908	0.2310
05-Feb-08	0.9099	0.91200	0.2310
06-Feb-08	0.7007	0.70232	0.2310
07-Feb-08	0.7004	0.70202	0.2310
08-Feb-08	0.6465	0.64799	0.2310
09-Feb-08	0.6416	0.64308	0.2310
10-Feb-08	0.6659	0.66744	0.2310
11-Feb-08	0.6851	0.68668	0.2310
12-Feb-08	0.6732	0.67476	0.2310

13-Feb-08	0.6391	0.64058	0.2310
14-Feb-08	0.7964	0.79824	0.2310
15-Feb-08	0.7968	0.79864	0.2310
16-Feb-08	0.7015	0.70312	0.2310
17-Feb-08	0.7004	0.70202	0.2310
18-Feb-08	0.6941	0.69570	0.2310
19-Feb-08	0.8959	0.89797	0.2310
20-Feb-08	0.7926	0.79443	0.2310
21-Feb-08	0.7020	0.70362	0.2310
22-Feb-08	0.6357	0.63717	0.2310
23-Feb-08	0.6516	0.65311	0.2310
24-Feb-08	0.6834	0.68498	0.2310
25-Feb-08	0.6725	0.67405	0.2310
26-Feb-08	0.4913	0.49243	0.2310
27-Feb-08	0.7992	0.80105	0.2310
28-Feb-08	0.5984	0.59978	0.2310
29-Feb-08	0.7288	0.73048	0.2310
01-Mar-08	0.5522	0.55348	0.2310
02-Mar-08	0.6964	0.69801	0.2310
03-Mar-08	0.7966	0.79844	0.2310
04-Mar-08	0.8011	0.80295	0.2310
05-Mar-08	0.7368	0.73850	0.2310
06-Mar-08	0.7357	0.73740	0.2310
07-Mar-08	0.5671	0.56841	0.2310
08-Mar-08	0.5721	0.57342	0.2310
09-Mar-08	0.5439	0.54516	0.2310
10-Mar-08	0.7442	0.74592	0.2310
11-Mar-08	0.6516	0.65311	0.2310
12-Mar-08	0.6452	0.64669	0.2310
13-Mar-08	0.7802	0.78200	0.2310
14-Mar-08	0.6375	0.63897	0.2310
15-Mar-08	0.5982	0.59958	0.2310
16-Mar-08	0.5979	0.59928	0.2310
17-Mar-08	0.5424	0.54365	0.2310
18-Mar-08	0.6250	0.62644	0.2310
19-Mar-08	0.5992	0.60058	0.2310
20-Mar-08	0.5985	0.59988	0.2310
21-Mar-08	0.5446	0.54586	0.2310
22-Mar-08	0.4851	0.48622	0.2310
23-Mar-08	0.5520	0.55328	0.2310
24-Mar-08	0.5981	0.59948	0.2310
25-Mar-08	0.5992	0.60058	0.2310
26-Mar-08	0.6003	0.60169	0.2310
27-Mar-08	0.5999	0.60129	0.2310
28-Mar-08	0.5376	0.53884	0.2310
29-Mar-08	0.4784	0.47951	0.2310
30-Mar-08	0.4257	0.42668	0.2310
31-Mar-08	0.3498	0.35061	0.2310

01-Apr-08	0.5392	0.54045	0.2310
02-Apr-08	0.5226	0.52381	0.2310
03-Apr-08	0.5125	0.51368	0.2310
04-Apr-08	0.4737	0.47479	0.2310
05-Apr-08	0.6431	0.64459	0.2310
06-Apr-08	0.6488	0.65030	0.2310
07-Apr-08	0.6793	0.68087	0.2310
08-Apr-08	0.6651	0.66664	0.2310
09-Apr-08	0.5172	0.51839	0.2310
10-Apr-08	0.5266	0.52782	0.2310
11-Apr-08	0.4912	0.49233	0.2310
12-Apr-08	0.4700	0.47109	0.2310
13-Apr-08	0.6842	0.68578	0.2310
14-Apr-08	0.6160	0.61742	0.2310
15-Apr-08	0.5785	0.57984	0.2310
16-Apr-08	0.6225	0.62394	0.2310
17-Apr-08	0.3809	0.38178	0.2310
18-Apr-08	0.4239	0.42488	0.2310
19-Apr-08	0.6042	0.60560	0.2310
20-Apr-08	0.5548	0.55608	0.2310
21-Apr-08	0.4794	0.48051	0.2310
22-Apr-08	0.4592	0.46026	0.2310
23-Apr-08	0.4918	0.49294	0.2310
24-Apr-08	0.4384	0.43855	0.0346