



# **ASSESSMENT OF ERROR DUE TO ORIFICE DIAMETER MIS-MEASUREMENT AT SHUSTOKE**

A Report for

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

PROJECT NO: NGR010

REPORT NO: 2010/247

DATE: 25 JUNE 2010



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

## **NOTES**

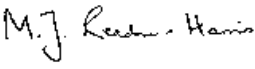
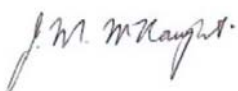
- 1** This report may be published in full by the client unless it includes information supplied in confidence by TUV NEL Ltd or any third party. Such information, if included within the report, shall be identified as confidential by TUV NEL Ltd.
- 2a** The prior written consent of TUV NEL Ltd shall 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](http://www.tuvnel.com)

## Assessment of Error Due to Orifice Diameter Mis-Measurement at Shustoke

A Report for

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

<b>Prepared by:</b>  	<b>Approved by:</b>  
<b>Dr M J Reader-Harris</b>	<b>J M McNaught</b>

for  
Michael Valente  
Managing Director

Date: 25 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 Shustoke a correction factor of 1.002421 should be applied during the period of mis-measurement.

Over the period 08/01/2008 to 05/12/2008 inclusive the flow was 164.75033 mscm and the corrected flow should be 165.14889 mscm.

**CONTENTS**

	<b>Page No</b>
EXECUTIVE SUMMARY .....	2
1 INTRODUCTION .....	4
2 ORIFICE DIAMETERS .....	4
3 CORRECTING THE FLOWRATE .....	5
4 CORRECTIONS ON A DAILY BASIS .....	6
5 CONCLUSIONS .....	7
APPENDIX A ORIFICE PLATE CALIBRATION CERTIFICATES .....	8
APPENDIX B CORRECTED DAILY VOLUME FLOWS .....	14

## 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 Shustoke in the period of the error. The Joint Office Error Code is WM006.

## 2 ORIFICE DIAMETERS

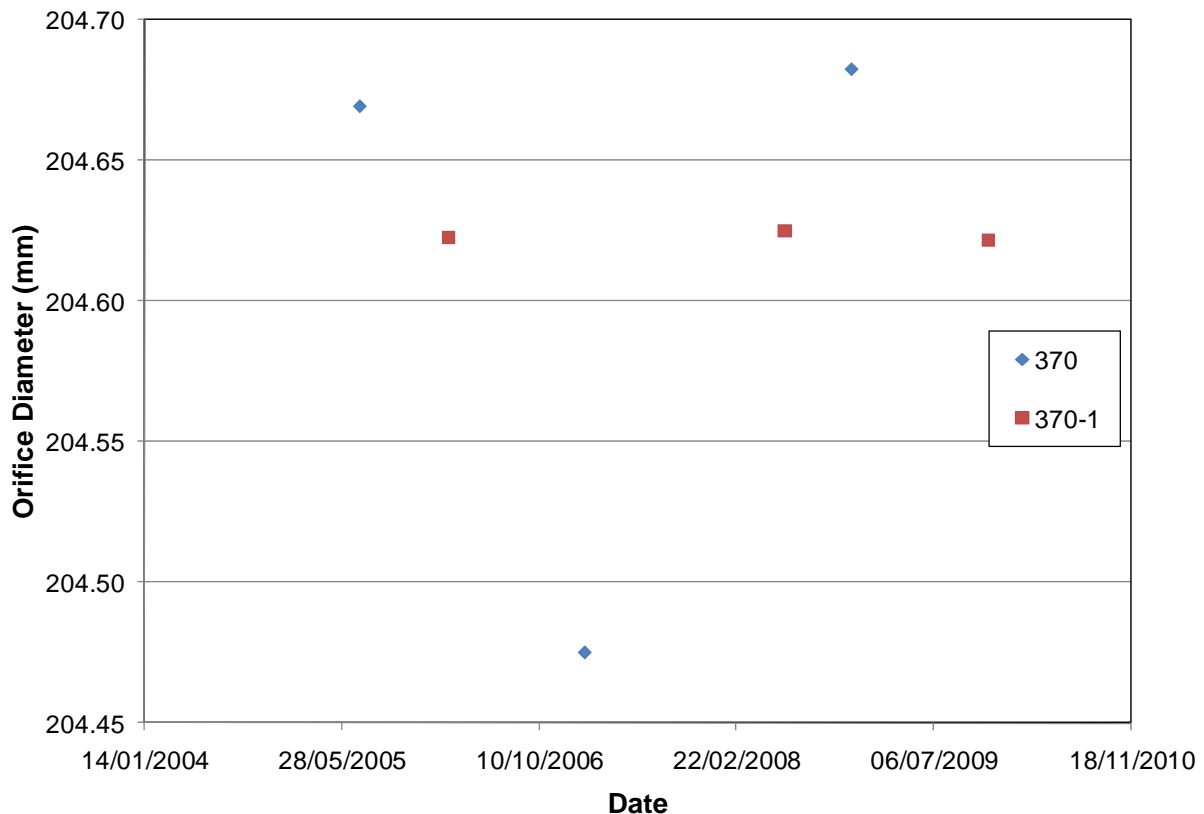
The calibrations of the orifice plates in question gave the measured diameters shown in Table 1. The diameters at 20 °C have been calculated.

**TABLE 1**  
**ORIFICE DIAMETERS**

Calibration Reference	Plate serial no	Declared certificate date	Orifice bore (mm)	Temperature	Value at 20 °C Orifice bore (mm)
OP50084	370	11/07/2005	204.6725	21	204.6692
OP60028	370-1	22/02/2006	204.6260	21	204.6227
OP70019	370	01/02/2007	204.4785	21	204.4752
OP80030	370-1	23/06/2008	204.6250	20	204.6250
OP80085	370	08/12/2008	204.6840	20.5	204.6824
OP90053	370-1	20/11/2009	204.6230	20.4	204.6217

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	omnM1011.cfg	omnN0108.cfg	omnN0111.cfg	omnN1205.cfg
	11/10/2007 23:01	09/01/2008 00:01	12/01/2008 00:01	06/12/2008 00:01
Orifice plate bore diameter (mm)	204.626	204.4785	204.4785	204.625
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)	304.8286	304.8286	304.8286	304.8286
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	1.3343	1.3343	1.338	1.338
Dynamic Viscosity (Pa.s)	0.0000118	0.0000118	0.0000118	0.0000118
Orifice plate certificate number	OP60028	OP70019	OP70019	OP80030
Orifice plate serial number	370-1	370	370	370-1
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,  $\varepsilon$  is the expansibility,  $\rho$  is the density,  $\Delta p$  is the differential pressure, and  $\beta$  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  $\varepsilon$  in each case, and they were determined from the equations in ISO 5167-1:1991.  $C$  is a function of  $\beta$  and  $Re_D$ ; so there is a change in  $C$  due to  $\beta$ , but the change varies with Reynolds number. Throughout the calculations the upstream pressure  $p_1$  is taken as 55 bar a; the change in  $q_{m,c}/q_{m,o}$  due to changing the static pressure by 10 bar is around 0.00004%.

Over the period from 08/01/2008 to 11/01/2008 the correction can be calculated as in Table 3; throughout this calculation the meter tube diameter is 304.8286 mm, the isentropic exponent is 1.3343 and the dynamic viscosity 0.0000118 Pa s.

TABLE 3

## THE CORRECTION FROM 08/01/2008 TO 11/01/2008

	$d$ mm	$\beta$	$\varepsilon$	$Re_D$	$C$	$\frac{q_{m,c}}{q_{m,o}}$
Original: $\Delta p=10$ mbar	204.4752	0.670788	0.999934	2473868	0.603445	
Corrected $\Delta p=10$ mbar	204.6758	0.671446	0.999934	2479861	0.603421	1.0024223
Original $\Delta p=500$ mbar	204.4752	0.670788	0.996724	17424678	0.603028	
Corrected $\Delta p=500$ mbar	204.6758	0.671446	0.996722	17466846	0.603004	1.0024200

So  $q_{m,c}/q_{m,o}$  is 1.002421.

Over the period from 11/01/2008 to 05/12/2008 the correction can be calculated as in Table 4; throughout this calculation the meter tube diameter is 304.8286 mm, the isentropic exponent is 1.338 and the dynamic viscosity 0.0000118 Pa s.

TABLE 4

## THE CORRECTION FROM 11/01/2008 TO 05/12/2008

	$d$ mm	$\beta$	$\varepsilon$	$Re_D$	$C$	$\frac{q_{m,c}}{q_{m,o}}$
Original: $\Delta p=10$ mbar	204.4752	0.670788	0.999935	2473869	0.603445	
Corrected $\Delta p=10$ mbar	204.6758	0.671446	0.999935	2479861	0.603421	1.0024223
Original $\Delta p=500$ mbar	204.4752	0.670788	0.996733	17424836	0.603028	
Corrected $\Delta p=500$ mbar	204.6758	0.671446	0.996731	17467004	0.603004	1.0024200

So  $q_{m,c}/q_{m,o}$  is 1.002421.

#### 4 CORRECTIONS ON A DAILY BASIS

The volume flows for each day from 08/01/2008 to 05/12/2008 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 08/01/2008 has to be corrected but none of that for 05/12/2008. Summing the data gives the figures in Table 5.

TABLE 5

## THE FLOW OVER THE PERIOD 08/01/2008 TO 05/12/2008 INCLUSIVE

Flow (mscm)	164.75033
Correction (mscm)	0.39856
Corrected flow (mscm)	165.14889
% change	0.2419



## 5 CONCLUSIONS

A correction factor of 1.002421 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:** OP50084  
**TEMPERATURE:** 21 degsC  
**MEASURED ORIFICE BORE:** 204.6725mm

**PLATE DETAILS**

PLATE SERIAL. 370	PLATE O.D 355.623mm		
MANUFACTURER:	PIPE I.D: 304.927mm	SITE: SHUSTOKE	
MATERIAL CERT.No	DESIGN BORE: 204.655mm	FLOW: 4500000 M <sup>3</sup> /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	3	4	5	6		
FLATNESS $\lambda$	0.164	0.175	0.171	0.184	0.171	0.205	0.191	0.184
'E' mm	6.350	6.343	6.337	6.346	6.356	6.349	6.345	6.352
'e' mm	5.270	5.276	5.266	5.257	5.273	5.262	5.248	5.270
EDGE SHARPNESS mm	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125
BEVEL ANGLE:	44 DEGS							
CONCENTRICITY	0.063mm							
SURFACE FINISH (Ra)	4.1 microns							
DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS								
ROUNDNESS :	0.014mm	TAPER: 0 degs						

COMMENTS:

INSPECTED BY...  G. WARDLE

VERIFIED BY...  P. KENNERSON

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 22-02-06  
 REF NO: OP60028  
 TEMPERATURE: 21 degsC

MEASURED ORIFICE BORE: 204.626mm

PLATE DETAILS

PLATE SERIAL: 370-1                      PLATE O.D      355.568mm  
 MANUFACTURER:                      PIPE I.D:      304.927mm      SITE:      SHUSTOKE  
 MATERIAL CERT.No                      DESIGN BORE      mm                      FLOW:      4.5\*10E06 M^3/DY

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	8
FLATNESS %	0.086	0.060	0.010	0.008	0.023	0.002	0.020	0.063
'E' mm	6.345	6.324	6.328	6.331	6.332	6.328	6.323	6.331
'e' mm	5.045	5.059	5.031	5.037	5.082	5.052	5.072	5.069
EDGE SHARPNESS mm	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125
BEVEL ANGLE:	36 DEGS							
CONCENTRICITY	0.088mm							
SURFACE FINISH (Ra):	7.0 microns							

DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS

ROUNDNESS      0.014mm                      TAPER:      0 degs

COMMENTS:

INSPECTED BY: *P. Kennerson* . P.KENNERSON

## NATIONAL GRID ORIFICE PLATE CALIBRATION

**DATE:** 01-02-07  
**REF NO:** OP70019  
**TEMPERATURE:** 21 degsC

**MEASURED ORIFICE BORE:** 204.4785mm

**PLATE DETAILS**

PLATE SERIAL.	370	PLATE O.D	355.668mm	SITE:	SHUSTOKE
MANUFACTURER:		PIPE I.D:	304.927mm	FLOW:	4.5X10E06 M <sup>3</sup> /DAY
MATERIAL CERT.No		DESIGN BORE	204.655mm		

**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 $\mu$	0.175	0.181	0.177	0.170	0.187	0.195	0.180	0.162
B' mm	6.405	6.326	6.324	6.402	6.403	6.333	6.331	6.402
e' mm		5.262	5.273	5.311	5.314	5.252	5.242	5.294
EDGE SHARPNESS mm	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125
BEVEL ANGLE:	44 DEGS							
CONCENTRICITY	0.593mm							
SURFACE FINISH (Ra)	4.6 microns							
DOWNSTREAM FACE/EDGE VISUAL INSPECTION	PASS							
ROUNDNESS	0.191mm	TAPER	0 degs					

COMMENTS:

INSPECTED BY:



P. KENNERSON

**NATIONAL GRID ORIFICE PLATE CALIBRATION**

**DATE:** 23-JUNE-2008

**REF NO:** OP80030

**TEMPERATURE:** 20 degsC

**MEASURED ORIFICE BORE:** 204.625mm

**PLATE DETAILS**

PLATE SERIAL.	370-1	PLATE O.D	355.565mm	SITE:	SHUSTOKE
MANUFACTURER:		PIPE I.D:	304.8286mm	DESIGN BORE:	mm
MATERIAL CERT.No.				FLOW:	4.5X10E06 M <sup>3</sup> /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 $\mu$	0.062	0.069	0.048			0.023	0.037	0.032
	6.336	6.317	6.318	6.325	6.322	6.315	6.314	6.330
Re mm	5.000	5.043	5.013	4.992	4.993	4.976	5.053	5.058
EDGE SHARPNESS mm	SQUARE	0.0125	SQUARE	0.0125	0.0125	0.0125	0.0125	SQUARE
BEVEL ANGLE:	35 DEGS							
CONCENTRICITY	0.058mm							
SURFACE FINISH (Ra)	3.0 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: 08-DEC-2008  
 REF NO: OP80085  
 TEMPERATURE: 20.5 degsC  
 MEASURED ORIFICE BORE: 204.684mm

PLATE DETAILS

PLATE SERIAL: 370 PLATE O.D: 355.626mm  
 MANUFACTURER: PIPE I.D: 304.8286mm SITE: SHUSTOKE  
 MATERIAL CERT.No DESIGN BORE: 204.655mm FLOW: 4.5X10E06 M<sup>3</sup>/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		
FLATNESS %	0.158	0.165	0.183	0.172	0.185	0.185	0.172	0.178
E' mm	6.339	6.335	6.332	6.331	6.335	6.351	6.348	6.342
e' mm	5.249	5.271	5.260	5.260	5.255	5.266	5.263	5.259
EDGE SHARPNESS mm	0.0125	0.025	0.0125	SQUARE	0.0125	0.025	0.025	0.025
BEVEL ANGLE:	44 DEGS							
CONCENTRICITY	0.059mm							
SURFACE FINISH (Ra)	3.2 microns							
DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS								
ROUNDNESS :	0.017mm	TAPER: 0 degs						

DRAINHOLE PRESENT ? (YES/NO): No

COMMENTS: LIGHT GREASE TO UPSTREAM FACE

INSPECTED BY:  M Livingstone.

**NATIONAL GRID ORIFICE PLATE CALIBRATION**

**DATE:** 20-NOV-2009

**REF NO:** OP90053

**TEMPERATURE:** 20.4 degsC

**MEASURED ORIFICE BORE:** 204.623mm

PLATE DETAILS

PLATE SERIAL:	370-1	PLATE O.D	355.556mm	SITE:	SHUSTOKE
MANUFACTURER:		PIPE I.D:	304.8286mm	FLOW:	4.5 X 10E06 M <sup>3</sup> /DAY
MATERIAL CERT.No.		DESIGN BORE:	mm		

TEST EQUIPMENT

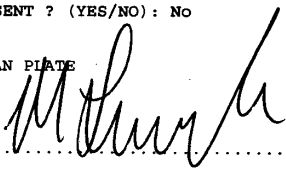
MANUFACTURER & TYPE: KEMCO 700 MANUAL 3-DIMENSIONAL MEASURING MACHINE -ASSET NO OP-A02  
 CALIBRATED BY: QUALITY CONTROL TECHNOLOGY, UKAS TRACEABLE CERT:- 7325. NEXT CAL DUE:- 02-OCTOBER-2010

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS:	1	2	3	4	5	6	7	
FLATNESS %	0.045	0.065	0.019	0.014	0.027	0.015	0.004	0.014
'E' mm	6.332	6.330	6.327	6.313	6.313	6.334	6.333	6.328
'e' mm	5.082	5.044	5.017	5.027	5.025	5.017	5.038	5.063
EDGE SHARPNESS mm	SQUARE	0.0125	SQUARE	0.0125	0.0125	0.0125	SQUARE	SQUARE
BEVEL ANGLE:	35 DEGS							
CONCENTRICITY	0.070mm							
SURFACE FINISH (Ra)	2.9 mic							
DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS								
ROUNDNESS :	0.007mm	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 SHUSTOKE DURING THE PERIOD OF THE MIS-MEASUREMENT

	Original Values (total)	Corrected values (total)	% increase
Date	Volume (mscm)	Volume (mscm)	Volume (mscm)
08-Jan-08	0.48780	<b>0.48898</b>	0.2421
09-Jan-08	0.00000	<b>0.00000</b>	0.0000
10-Jan-08	0.00000	<b>0.00000</b>	0.0000
11-Jan-08	0.02010	<b>0.02015</b>	0.2421
12-Jan-08	0.00000	<b>0.00000</b>	0.0000
13-Jan-08	0.00000	<b>0.00000</b>	0.0000
14-Jan-08	0.00000	<b>0.00000</b>	0.0000
15-Jan-08	0.00000	<b>0.00000</b>	0.0000
16-Jan-08	0.19040	<b>0.19086</b>	0.2421
17-Jan-08	0.06980	<b>0.06997</b>	0.2421
18-Jan-08	0.33101	<b>0.33181</b>	0.2421
19-Jan-08	2.42510	<b>2.43097</b>	0.2421
20-Jan-08	2.61700	<b>2.62334</b>	0.2421
21-Jan-08	0.00000	<b>0.00000</b>	0.0000
22-Jan-08	0.00000	<b>0.00000</b>	0.0000
23-Jan-08	0.00000	<b>0.00000</b>	0.0000
24-Jan-08	0.00000	<b>0.00000</b>	0.0000
25-Jan-08	0.00000	<b>0.00000</b>	0.0000
26-Jan-08	0.00000	<b>0.00000</b>	0.0000
27-Jan-08	0.00000	<b>0.00000</b>	0.0000
28-Jan-08	0.00000	<b>0.00000</b>	0.0000
29-Jan-08	0.00000	<b>0.00000</b>	0.0000
30-Jan-08	0.00000	<b>0.00000</b>	0.0000
31-Jan-08	0.00000	<b>0.00000</b>	0.0000
01-Feb-08	0.00000	<b>0.00000</b>	0.0000
02-Feb-08	0.00000	<b>0.00000</b>	0.0000
03-Feb-08	0.00000	<b>0.00000</b>	0.0000
04-Feb-08	0.00000	<b>0.00000</b>	0.0000
05-Feb-08	0.00000	<b>0.00000</b>	0.0000
06-Feb-08	0.00000	<b>0.00000</b>	0.0000
07-Feb-08	0.09790	<b>0.09814</b>	0.2421
08-Feb-08	0.00000	<b>0.00000</b>	0.0000
09-Feb-08	0.00000	<b>0.00000</b>	0.0000
10-Feb-08	0.00000	<b>0.00000</b>	0.0000
11-Feb-08	0.00000	<b>0.00000</b>	0.0000
12-Feb-08	0.00000	<b>0.00000</b>	0.0000
13-Feb-08	0.00000	<b>0.00000</b>	0.0000
14-Feb-08	0.00000	<b>0.00000</b>	0.0000
15-Feb-08	0.00000	<b>0.00000</b>	0.0000



16-Feb-08	0.00000	<b>0.00000</b>	0.0000
17-Feb-08	0.00000	<b>0.00000</b>	0.0000
18-Feb-08	0.00000	<b>0.00000</b>	0.0000
19-Feb-08	0.00000	<b>0.00000</b>	0.0000
20-Feb-08	0.00000	<b>0.00000</b>	0.0000
21-Feb-08	0.00000	<b>0.00000</b>	0.0000
22-Feb-08	0.00000	<b>0.00000</b>	0.0000
23-Feb-08	0.00000	<b>0.00000</b>	0.0000
24-Feb-08	0.00000	<b>0.00000</b>	0.0000
25-Feb-08	0.00000	<b>0.00000</b>	0.0000
26-Feb-08	0.00000	<b>0.00000</b>	0.0000
27-Feb-08	0.00000	<b>0.00000</b>	0.0000
28-Feb-08	0.12560	<b>0.12590</b>	0.2421
29-Feb-08	0.00000	<b>0.00000</b>	0.0000
01-Mar-08	0.00000	<b>0.00000</b>	0.0000
02-Mar-08	0.00000	<b>0.00000</b>	0.0000
03-Mar-08	0.00000	<b>0.00000</b>	0.0000
04-Mar-08	0.00000	<b>0.00000</b>	0.0000
05-Mar-08	0.00000	<b>0.00000</b>	0.0000
06-Mar-08	0.00000	<b>0.00000</b>	0.0000
07-Mar-08	0.00000	<b>0.00000</b>	0.0000
08-Mar-08	0.00000	<b>0.00000</b>	0.0000
09-Mar-08	0.00000	<b>0.00000</b>	0.0000
10-Mar-08	0.00000	<b>0.00000</b>	0.0000
11-Mar-08	0.00000	<b>0.00000</b>	0.0000
12-Mar-08	0.24870	<b>0.24930</b>	0.2421
13-Mar-08	0.00000	<b>0.00000</b>	0.0000
14-Mar-08	0.00000	<b>0.00000</b>	0.0000
15-Mar-08	0.00000	<b>0.00000</b>	0.0000
16-Mar-08	0.29620	<b>0.29692</b>	0.2421
17-Mar-08	0.00000	<b>0.00000</b>	0.0000
18-Mar-08	0.00000	<b>0.00000</b>	0.0000
19-Mar-08	0.00000	<b>0.00000</b>	0.0000
20-Mar-08	0.00000	<b>0.00000</b>	0.0000
21-Mar-08	0.00000	<b>0.00000</b>	0.0000
22-Mar-08	0.00000	<b>0.00000</b>	0.0000
23-Mar-08	0.00000	<b>0.00000</b>	0.0000
24-Mar-08	0.00000	<b>0.00000</b>	0.0000
25-Mar-08	0.00000	<b>0.00000</b>	0.0000
26-Mar-08	0.00000	<b>0.00000</b>	0.0000
27-Mar-08	0.00000	<b>0.00000</b>	0.0000
28-Mar-08	0.00000	<b>0.00000</b>	0.0000
29-Mar-08	0.78010	<b>0.78199</b>	0.2421
30-Mar-08	1.73410	<b>1.73830</b>	0.2421
31-Mar-08	2.07050	<b>2.07551</b>	0.2421
01-Apr-08	2.09520	<b>2.10027</b>	0.2421
02-Apr-08	2.46150	<b>2.46746</b>	0.2421
03-Apr-08	2.00160	<b>2.00645</b>	0.2421

04-Apr-08	1.97771	<b>1.98250</b>	0.2421
05-Apr-08	2.68510	<b>2.69160</b>	0.2421
06-Apr-08	3.14110	<b>3.14870</b>	0.2421
07-Apr-08	2.70760	<b>2.71416</b>	0.2421
08-Apr-08	2.60080	<b>2.60710</b>	0.2421
09-Apr-08	2.39470	<b>2.40050</b>	0.2421
10-Apr-08	2.43260	<b>2.43849</b>	0.2421
11-Apr-08	2.39640	<b>2.40220</b>	0.2421
12-Apr-08	1.96819	<b>1.97295</b>	0.2421
13-Apr-08	2.43370	<b>2.43959</b>	0.2421
14-Apr-08	2.33000	<b>2.33564</b>	0.2421
15-Apr-08	1.72320	<b>1.72737</b>	0.2421
16-Apr-08	0.00000	<b>0.00000</b>	0.0000
17-Apr-08	0.00000	<b>0.00000</b>	0.0000
18-Apr-08	0.00000	<b>0.00000</b>	0.0000
19-Apr-08	0.00000	<b>0.00000</b>	0.0000
20-Apr-08	0.00000	<b>0.00000</b>	0.0000
21-Apr-08	1.58440	<b>1.58824</b>	0.2421
22-Apr-08	2.14560	<b>2.15079</b>	0.2421
23-Apr-08	1.82770	<b>1.83212</b>	0.2421
24-Apr-08	2.15201	<b>2.15722</b>	0.2421
25-Apr-08	1.75780	<b>1.76206</b>	0.2421
26-Apr-08	1.22100	<b>1.22396</b>	0.2421
27-Apr-08	0.00000	<b>0.00000</b>	0.0000
28-Apr-08	1.60610	<b>1.60999</b>	0.2421
29-Apr-08	2.25680	<b>2.26226</b>	0.2421
30-Apr-08	1.93900	<b>1.94369</b>	0.2421
01-May-08	1.68180	<b>1.68587</b>	0.2421
02-May-08	1.91480	<b>1.91944</b>	0.2421
03-May-08	0.00000	<b>0.00000</b>	0.0000
04-May-08	0.00000	<b>0.00000</b>	0.0000
05-May-08	0.00000	<b>0.00000</b>	0.0000
06-May-08	0.00000	<b>0.00000</b>	0.0000
07-May-08	0.00000	<b>0.00000</b>	0.0000
08-May-08	0.00000	<b>0.00000</b>	0.0000
09-May-08	0.06480	<b>0.06496</b>	0.2421
10-May-08	0.00000	<b>0.00000</b>	0.0000
11-May-08	0.00000	<b>0.00000</b>	0.0000
12-May-08	0.00000	<b>0.00000</b>	0.0000
13-May-08	0.00000	<b>0.00000</b>	0.0000
14-May-08	0.00000	<b>0.00000</b>	0.0000
15-May-08	0.00000	<b>0.00000</b>	0.0000
16-May-08	0.00000	<b>0.00000</b>	0.0000
17-May-08	0.00000	<b>0.00000</b>	0.0000
18-May-08	0.00000	<b>0.00000</b>	0.0000
19-May-08	0.00000	<b>0.00000</b>	0.0000
20-May-08	0.00000	<b>0.00000</b>	0.0000
21-May-08	0.00000	<b>0.00000</b>	0.0000

22-May-08	0.00000	<b>0.00000</b>	0.0000
23-May-08	0.00000	<b>0.00000</b>	0.0000
24-May-08	0.00000	<b>0.00000</b>	0.0000
25-May-08	0.00000	<b>0.00000</b>	0.0000
26-May-08	0.78450	<b>0.78640</b>	0.2421
27-May-08	0.43600	<b>0.43706</b>	0.2421
28-May-08	0.86830	<b>0.87040</b>	0.2421
29-May-08	0.00000	<b>0.00000</b>	0.0000
30-May-08	0.02760	<b>0.02767</b>	0.2421
31-May-08	0.00000	<b>0.00000</b>	0.0000
01-Jun-08	0.00000	<b>0.00000</b>	0.0000
02-Jun-08	0.00000	<b>0.00000</b>	0.0000
03-Jun-08	0.00000	<b>0.00000</b>	0.0000
04-Jun-08	0.00000	<b>0.00000</b>	0.0000
05-Jun-08	0.00000	<b>0.00000</b>	0.0000
06-Jun-08	0.00000	<b>0.00000</b>	0.0000
07-Jun-08	0.00000	<b>0.00000</b>	0.0000
08-Jun-08	0.00000	<b>0.00000</b>	0.0000
09-Jun-08	0.00000	<b>0.00000</b>	0.0000
10-Jun-08	0.00000	<b>0.00000</b>	0.0000
11-Jun-08	0.00000	<b>0.00000</b>	0.0000
12-Jun-08	0.00000	<b>0.00000</b>	0.0000
13-Jun-08	0.00000	<b>0.00000</b>	0.0000
14-Jun-08	0.00000	<b>0.00000</b>	0.0000
15-Jun-08	0.00000	<b>0.00000</b>	0.0000
16-Jun-08	0.00000	<b>0.00000</b>	0.0000
17-Jun-08	0.00000	<b>0.00000</b>	0.0000
18-Jun-08	0.00000	<b>0.00000</b>	0.0000
19-Jun-08	0.00000	<b>0.00000</b>	0.0000
20-Jun-08	0.00000	<b>0.00000</b>	0.0000
21-Jun-08	0.00000	<b>0.00000</b>	0.0000
22-Jun-08	0.00000	<b>0.00000</b>	0.0000
23-Jun-08	0.00000	<b>0.00000</b>	0.0000
24-Jun-08	0.00000	<b>0.00000</b>	0.0000
25-Jun-08	0.00000	<b>0.00000</b>	0.0000
26-Jun-08	0.00000	<b>0.00000</b>	0.0000
27-Jun-08	0.00000	<b>0.00000</b>	0.0000
28-Jun-08	0.00000	<b>0.00000</b>	0.0000
29-Jun-08	0.00000	<b>0.00000</b>	0.0000
30-Jun-08	0.00000	<b>0.00000</b>	0.0000
01-Jul-08	0.00000	<b>0.00000</b>	0.0000
02-Jul-08	0.00000	<b>0.00000</b>	0.0000
03-Jul-08	0.00000	<b>0.00000</b>	0.0000
04-Jul-08	0.13260	<b>0.13292</b>	0.2421
05-Jul-08	0.00000	<b>0.00000</b>	0.0000
06-Jul-08	0.00000	<b>0.00000</b>	0.0000
07-Jul-08	0.00000	<b>0.00000</b>	0.0000
08-Jul-08	0.00000	<b>0.00000</b>	0.0000

09-Jul-08	0.00000	<b>0.00000</b>	0.0000
10-Jul-08	0.00000	<b>0.00000</b>	0.0000
11-Jul-08	0.00000	<b>0.00000</b>	0.0000
12-Jul-08	0.00000	<b>0.00000</b>	0.0000
13-Jul-08	0.00000	<b>0.00000</b>	0.0000
14-Jul-08	0.00000	<b>0.00000</b>	0.0000
15-Jul-08	0.00000	<b>0.00000</b>	0.0000
16-Jul-08	0.00000	<b>0.00000</b>	0.0000
17-Jul-08	0.00000	<b>0.00000</b>	0.0000
18-Jul-08	0.00000	<b>0.00000</b>	0.0000
19-Jul-08	0.00000	<b>0.00000</b>	0.0000
20-Jul-08	0.00000	<b>0.00000</b>	0.0000
21-Jul-08	0.00000	<b>0.00000</b>	0.0000
22-Jul-08	0.00000	<b>0.00000</b>	0.0000
23-Jul-08	0.00000	<b>0.00000</b>	0.0000
24-Jul-08	0.00000	<b>0.00000</b>	0.0000
25-Jul-08	0.00000	<b>0.00000</b>	0.0000
26-Jul-08	0.00000	<b>0.00000</b>	0.0000
27-Jul-08	0.00000	<b>0.00000</b>	0.0000
28-Jul-08	0.00000	<b>0.00000</b>	0.0000
29-Jul-08	0.00000	<b>0.00000</b>	0.0000
30-Jul-08	0.00000	<b>0.00000</b>	0.0000
31-Jul-08	0.00000	<b>0.00000</b>	0.0000
01-Aug-08	0.00000	<b>0.00000</b>	0.0000
02-Aug-08	0.00000	<b>0.00000</b>	0.0000
03-Aug-08	0.00000	<b>0.00000</b>	0.0000
04-Aug-08	0.00000	<b>0.00000</b>	0.0000
05-Aug-08	0.00000	<b>0.00000</b>	0.0000
06-Aug-08	0.00000	<b>0.00000</b>	0.0000
07-Aug-08	0.00000	<b>0.00000</b>	0.0000
08-Aug-08	0.00000	<b>0.00000</b>	0.0000
09-Aug-08	0.00000	<b>0.00000</b>	0.0000
10-Aug-08	0.00000	<b>0.00000</b>	0.0000
11-Aug-08	0.00540	<b>0.00541</b>	0.2421
12-Aug-08	0.00000	<b>0.00000</b>	0.0000
13-Aug-08	0.00000	<b>0.00000</b>	0.0000
14-Aug-08	0.00000	<b>0.00000</b>	0.0000
15-Aug-08	0.00000	<b>0.00000</b>	0.0000
16-Aug-08	0.00000	<b>0.00000</b>	0.0000
17-Aug-08	0.00000	<b>0.00000</b>	0.0000
18-Aug-08	0.00000	<b>0.00000</b>	0.0000
19-Aug-08	0.00000	<b>0.00000</b>	0.0000
20-Aug-08	0.00000	<b>0.00000</b>	0.0000
21-Aug-08	0.00000	<b>0.00000</b>	0.0000
22-Aug-08	0.00000	<b>0.00000</b>	0.0000
23-Aug-08	0.00000	<b>0.00000</b>	0.0000
24-Aug-08	0.00000	<b>0.00000</b>	0.0000
25-Aug-08	0.00000	<b>0.00000</b>	0.0000

26-Aug-08	0.00640	<b>0.00642</b>	0.2421
27-Aug-08	0.00000	<b>0.00000</b>	0.0000
28-Aug-08	0.00000	<b>0.00000</b>	0.0000
29-Aug-08	0.00000	<b>0.00000</b>	0.0000
30-Aug-08	0.00000	<b>0.00000</b>	0.0000
31-Aug-08	0.00000	<b>0.00000</b>	0.0000
01-Sep-08	0.00000	<b>0.00000</b>	0.0000
02-Sep-08	0.00000	<b>0.00000</b>	0.0000
03-Sep-08	0.00000	<b>0.00000</b>	0.0000
04-Sep-08	0.00000	<b>0.00000</b>	0.0000
05-Sep-08	0.00000	<b>0.00000</b>	0.0000
06-Sep-08	0.00000	<b>0.00000</b>	0.0000
07-Sep-08	0.00000	<b>0.00000</b>	0.0000
08-Sep-08	0.00000	<b>0.00000</b>	0.0000
09-Sep-08	0.00000	<b>0.00000</b>	0.0000
10-Sep-08	0.00000	<b>0.00000</b>	0.0000
11-Sep-08	0.00000	<b>0.00000</b>	0.0000
12-Sep-08	0.00000	<b>0.00000</b>	0.0000
13-Sep-08	0.00000	<b>0.00000</b>	0.0000
14-Sep-08	0.00000	<b>0.00000</b>	0.0000
15-Sep-08	0.00000	<b>0.00000</b>	0.0000
16-Sep-08	0.00000	<b>0.00000</b>	0.0000
17-Sep-08	0.00000	<b>0.00000</b>	0.0000
18-Sep-08	0.00000	<b>0.00000</b>	0.0000
19-Sep-08	0.00000	<b>0.00000</b>	0.0000
20-Sep-08	0.00000	<b>0.00000</b>	0.0000
21-Sep-08	0.00000	<b>0.00000</b>	0.0000
22-Sep-08	0.00000	<b>0.00000</b>	0.0000
23-Sep-08	0.00000	<b>0.00000</b>	0.0000
24-Sep-08	0.00000	<b>0.00000</b>	0.0000
25-Sep-08	0.00000	<b>0.00000</b>	0.0000
26-Sep-08	0.00000	<b>0.00000</b>	0.0000
27-Sep-08	0.00000	<b>0.00000</b>	0.0000
28-Sep-08	0.00000	<b>0.00000</b>	0.0000
29-Sep-08	1.19190	<b>1.19479</b>	0.2421
30-Sep-08	1.45550	<b>1.45902</b>	0.2421
01-Oct-08	1.75550	<b>1.75975</b>	0.2421
02-Oct-08	1.81130	<b>1.81569</b>	0.2421
03-Oct-08	2.05670	<b>2.06168</b>	0.2421
04-Oct-08	2.02040	<b>2.02529</b>	0.2421
05-Oct-08	1.88780	<b>1.89237</b>	0.2421
06-Oct-08	2.22760	<b>2.23299</b>	0.2421
07-Oct-08	1.63410	<b>1.63806</b>	0.2421
08-Oct-08	1.97490	<b>1.97968</b>	0.2421
09-Oct-08	1.94880	<b>1.95352</b>	0.2421
10-Oct-08	1.62450	<b>1.62843</b>	0.2421
11-Oct-08	1.90030	<b>1.90490</b>	0.2421
12-Oct-08	1.60710	<b>1.61099</b>	0.2421

13-Oct-08	1.81660	<b>1.82100</b>	0.2421
14-Oct-08	2.26840	<b>2.27389</b>	0.2421
15-Oct-08	2.02550	<b>2.03040</b>	0.2421
16-Oct-08	2.30310	<b>2.30868</b>	0.2421
17-Oct-08	2.39740	<b>2.40320</b>	0.2421
18-Oct-08	1.65390	<b>1.65790</b>	0.2421
19-Oct-08	2.37840	<b>2.38416</b>	0.2421
20-Oct-08	2.06110	<b>2.06609</b>	0.2421
21-Oct-08	2.36070	<b>2.36642</b>	0.2421
22-Oct-08	3.12550	<b>3.13307</b>	0.2421
23-Oct-08	2.72550	<b>2.73210</b>	0.2421
24-Oct-08	1.89560	<b>1.90019</b>	0.2421
25-Oct-08	2.49860	<b>2.50465</b>	0.2421
26-Oct-08	1.84600	<b>1.85047</b>	0.2421
27-Oct-08	0.96360	<b>0.96593</b>	0.2421
28-Oct-08	1.30290	<b>1.30605</b>	0.2421
29-Oct-08	0.29390	<b>0.29461</b>	0.2421
30-Oct-08	2.49380	<b>2.49984</b>	0.2421
31-Oct-08	2.16529	<b>2.17053</b>	0.2421
01-Nov-08	1.56741	<b>1.57120</b>	0.2421
02-Nov-08	2.52460	<b>2.53071</b>	0.2421
03-Nov-08	2.11650	<b>2.12162</b>	0.2421
04-Nov-08	2.70730	<b>2.71385</b>	0.2421
05-Nov-08	2.56710	<b>2.57331</b>	0.2421
06-Nov-08	2.80470	<b>2.81149</b>	0.2421
07-Nov-08	2.10750	<b>2.11260</b>	0.2421
08-Nov-08	2.50920	<b>2.51527</b>	0.2421
09-Nov-08	1.65760	<b>1.66161</b>	0.2421
10-Nov-08	0.00000	<b>0.00000</b>	0.0000
11-Nov-08	0.00000	<b>0.00000</b>	0.0000
12-Nov-08	0.00000	<b>0.00000</b>	0.0000
13-Nov-08	0.60160	<b>0.60306</b>	0.2421
14-Nov-08	1.96410	<b>1.96886</b>	0.2421
15-Nov-08	1.65600	<b>1.66001</b>	0.2421
16-Nov-08	1.83131	<b>1.83574</b>	0.2421
17-Nov-08	1.82180	<b>1.82621</b>	0.2421
18-Nov-08	0.00000	<b>0.00000</b>	0.0000
19-Nov-08	0.00000	<b>0.00000</b>	0.0000
20-Nov-08	1.85190	<b>1.85638</b>	0.2421
21-Nov-08	1.00740	<b>1.00984</b>	0.2421
22-Nov-08	0.00000	<b>0.00000</b>	0.0000
23-Nov-08	0.00000	<b>0.00000</b>	0.0000
24-Nov-08	0.00000	<b>0.00000</b>	0.0000
25-Nov-08	0.00000	<b>0.00000</b>	0.0000
26-Nov-08	0.37550	<b>0.37641</b>	0.2421
27-Nov-08	0.00000	<b>0.00000</b>	0.0000
28-Nov-08	0.00000	<b>0.00000</b>	0.0000
29-Nov-08	0.00000	<b>0.00000</b>	0.0000

---

30-Nov-08	0.00000	<b>0.00000</b>	0.0000
01-Dec-08	0.02790	<b>0.02797</b>	0.2421
02-Dec-08	0.00000	<b>0.00000</b>	0.0000
03-Dec-08	0.00000	<b>0.00000</b>	0.0000
04-Dec-08	0.00000	<b>0.00000</b>	0.0000
05-Dec-08	0.12240	<b>0.12240</b>	0.0000