



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

A Report for

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

PROJECT NO: NGR010

REPORT NO: 2010/229

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**


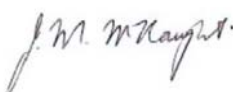
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## Assessment of Error Due to Orifice Diameter Mis-Measurement at Ecclestone

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 Ecclestone a correction factor of 1.002003 should be applied during the period of mis-measurement.

Over the period 27/06/2007 to 20/06/2008 inclusive the flow was 211.9963 mscm and the corrected flow should be 212.4209 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 Ecclestone in the period of the error. The Joint Office Error Code is NW003.

## 2 ORIFICE DIAMETERS

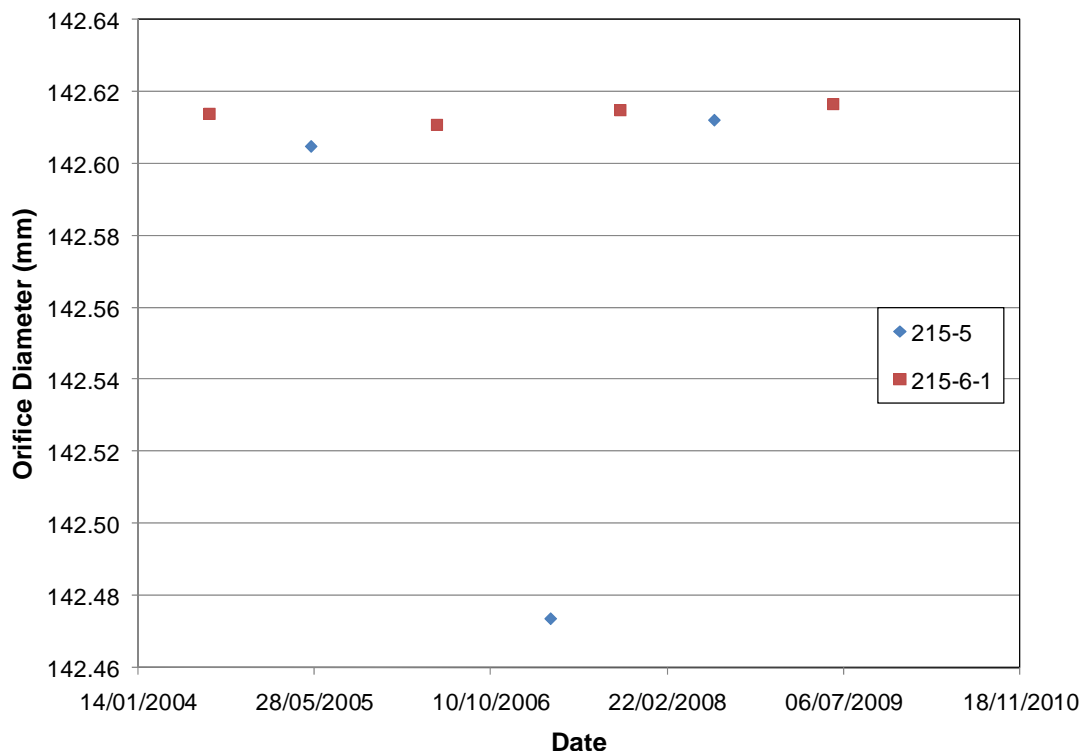
The calibrations of the orifice plates in question gave the measured diameters shown in Table 1. The diameters at 20 °C have been calculated.

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

Calibration Reference	Plate serial no	Declared certificate date	Orifice bore (mm)	Temperature	Value at 20 °C Orifice bore (mm)
OP4123	215-6-1	03/08/2004	142.616	21	142.6137
OP4173	215-5	18/05/2005	142.607	21	142.6047
OP50133	215-6-1	10/05/2006	142.613	21	142.6107
OP70015	215-5	28/03/2007	142.476	21	142.4737
OP70102	215-6-1	11/10/2007	142.615	20	142.6150
OP80034	215-5	04/07/2008	142.612	20	142.6120
OP90021	215-6-1	05/06/2009	142.618	20.6	142.6166

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	omnM0625.cfg	omnM0627.cfg	omnN0520.cfg	omnN0620.cfg
	25/06/2007 23:01	27/06/2007 23:01	20/05/2008 23:01	20/06/2008 23:01
Orifice plate bore diameter (mm)	142.613	142.476	142.476	142.615
Expansion coefficient of the plate (1/°C)	0.000016	0.000016	0.000016	0.000016
Orifice plate calibration temperature	21	21	21	20
Meter tube diameter (mm)	304.9969	304.9969	304.9969	304.9969
Expansion coefficient of the meter tube (1/°C)	0.000011	0.000011	0.000011	0.000011
Meter tube calibration temperature	20	20	20	20
Isentropic Exponent	1.3423	1.3423	1.3464	1.3464
Dynamic Viscosity (Pa.s)	0.0000121	0.0000121	0.0000121	0.0000121
Orifice plate certificate number	OP50133	OP70015	OP70015	OP70102
Orifice plate serial number	215-6-1	215-5	215-5	215-6-1
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 59 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 20/05/2008 the correction can be calculated as in Table 3; throughout this calculation the meter tube diameter is 304.9969 mm, the isentropic exponent is 1.3423 and the dynamic viscosity 0.0000121 Pa s.

**TABLE 3**  
**THE CORRECTION FROM 27/06/2007 TO 20/05/2008**

	$d$ mm	$\beta$	$\varepsilon$	$Re_D$	$C$	$\frac{q_{m,c}}{q_{m,o}}$
Original: $\Delta p=10$ mbar	142.4737	0.467132	0.999946	1112087	0.602280	
Corrected $\Delta p=10$ mbar	142.6084	0.467573	0.999946	1114315	0.602290	1.0020030
Original $\Delta p=500$ mbar	142.4737	0.467132	0.997306	7838883	0.601973	
Corrected $\Delta p=500$ mbar	142.6084	0.467573	0.997306	7854578	0.601983	1.0020022

So  $q_{m,c}/q_{m,o}$  is 1.002003.

Over the period from 20/05/2008 to 20/06/2008 the correction can be calculated as in Table 4; throughout this calculation the meter tube diameter is 304.9969 mm, the isentropic exponent is 1.3464 and the dynamic viscosity 0.0000121 Pa s.

**TABLE 4**  
**THE CORRECTION FROM 20/05/2008 TO 20/06/2008**

	$d$ mm	$\beta$	$\varepsilon$	$Re_D$	$C$	$\frac{q_{m,c}}{q_{m,o}}$
Original: $\Delta p=10$ mbar	142.4737	0.467132	0.999946	1112087	0.602280	
Corrected $\Delta p=10$ mbar	142.6084	0.467573	0.999946	1114315	0.602290	1.0020030
Original $\Delta p=500$ mbar	142.4737	0.467132	0.997314	7838948	0.601973	
Corrected $\Delta p=500$ mbar	142.6084	0.467573	0.997314	7854642	0.601983	1.0020022

So  $q_{m,c}/q_{m,o}$  is 1.002003.

#### 4 CORRECTIONS ON A DAILY BASIS

The volume flows for each day from 27/06/2007 to 20/06/2008 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 the whole flow for 27/06/2007 has to be corrected for but none of that for 20/06/2008. Summing the data gives the figures in Table 5.



**TABLE 5****THE FLOW OVER THE PERIOD 27/06/2007 TO 20/06/2008 INCLUSIVE**

Flow (mscm)	211.9963
Correction (mscm)	0.4246
Corrected flow (mscm)	212.4209
% change	0.2003

**5 CONCLUSIONS**

A correction factor of 1.002003 should be applied during the period of mis-measurement.

**APPENDIX A**  
**ORIFICE PLATE CALIBRATION CERTIFICATES**  
**TRANSCO ORIFICE PLATE CALIBRATION**

**DATE:** 03-08-04

**REF NO:** OP4123

**TEMPERATURE:** 21 degsC

**MEASURED ORIFICE BORE:** 142.616mm

**PLATE DETAILS**

PLATE SERIAL.	215-6-1	PLATE O.D	332.152mm	SITE:	ECCLESTON FERRY
MANUFACTURER:	DANIEL	PIPE I.D:	mm	FLOW:	
MATERIAL CERT.No	T7259	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	3	4	5	6	7	8
FLATNESS $\mu$		0.042	0.046	0.176	0.055	0.071	0.009	0.038
$\bar{E}$ mm	6.420	6.428	6.446	6.431	6.436	6.414	6.402	6.408
$\bar{e}$ mm	4.606	4.685	4.721	4.690	4.699	4.696	4.628	4.596
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) 1.0 microns

DOWNSTREAM FACE/EDGE VISUAL INSPECTION : PASS

ROUNDNESS 0.008mm TAPER 0 degs

BEVEL ANGLE 39DEGS

**COMMENTS**

INSPECTED BY  G. WARDLE

VERIFIED BY  P. KENNERSON

**TRANSCO ORIFICE PLATE CALIBRATION**

**DATE:** 18-05-05  
**REF NO:** OP4173  
**TEMPERATURE:** 21 degsC

**MEASURED ORIFICE BORE:** 142.607mm

**PLATE DETAILS**

PLATE SERIAL. 215-5 PLATE O.D 332.844mm  
 MANUFACTURER: DANIEL PIPE I.D: mm SITE: ECCLESTON FERRY  
 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:- 15/10/05

**UPSTREAM FACE INSPECTION RESULTS (ISO 5167)**

STATIONS:	1	3	4	5	6		
FLATNESS $\mu$	0.188	0.023	0.196	0.121	0.198	0.100	0.194 0.3
	6.376	6.358	6.333	6.338	6.285	6.295	6.333
	4.247		4.158	4.277	4.211	4.169	4.260
EDGE SHARPNESS mm	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125 0.01
BEVEL ANGLE	37 DEGS						
CONCENTRICITY	0.636mm						
SURFACE FINISH (Ra)	4.0 microns						
DOWNSTREAM FACE/EDGE VISUAL INSPECTION	PASS						
ROUNDNESS 0.018mm	TAPER 0 degs						

**COMMENTS**

INSPECTED BY *G. Wardle* G. WARDLE  
 VERIFIED BY *M. J. Penner* P. PENNERSON

**NATIONAL GRID ORIFICE PLATE CALIBRATION**

**DATE:** 10-05-06  
**REF NO:** OP50133  
**TEMPERATURE:** 21 degsC

**MEASURED ORIFICE BORE:** 142.613mm

**PLATE DETAILS**

PLATE SERIAL. 215-6-1 PLATE O.D 332.003mm  
 MANUFACTURER: DANIEL PIPE I.D: mm SITE: ECCLESTON FERRY  
 MATERIAL CERT.No T7259 DESIGN BORE: mm FLOW:

**TEST EQUIPMENT**

MANUFACTURER & TYPE: KEMCO 700 MANUAL 3-DIMENSIONAL MEASURING MACHINE -ASSET NO OP-A02  
 CALIBRATED BY: QUALITY CONTROL TECHNOLOGY, CERT:- 4820 NEXT CAL DUE:- 14/10/06

**UPSTREAM FACE INSPECTION RESULTS (ISO 5167)**

STATIONS:-	1	2	3	4	5	6	7	8
FLATNESS $\mu$	0.002	0.063	0.058	0.108	0.066	0.092	0.012	0.031
'E' mm	6.413	6.422	6.439	6.433	6.437	6.420	6.408	6.402
	4.610	4.675	4.716	4.695	4.713	4.702	4.618	4.594
EDGE SHARPNESS mm	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125
BEVEL ANGLE:	39 DEGS							
CONCENTRICITY	0.091mm							
SURFACE FINISH (Ra)	1.2 microns							
DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS								
ROUNDNESS	0.011mm	TAPER:		0 degs				

COMMENTS:

INSPECTED BY:



P. KENNERSON

## NATIONAL GRID ORIFICE PLATE CALIBRATION

**DATE:** 28-03-07  
**REF NO:** OP70015  
**TEMPERATURE:** 21 degsC

**MEASURED ORIFICE BORE:** 142.476mm

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**PLATE DETAILS**

PLATE SERIAL.	215-5	PLATE O.D	332.582mm	SITE	ECCLESTON FERRY
MANUFACTURER:	DANIEL	PIPE I.D:	mm	FLOW	
MATERIAL CERT.No		DESIGN BORE	mm		

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**TEST EQUIPMENT**

MANUFACTURER & TYPE: KEMCO 700 MANUAL 3-DIMENSIONAL MEASURING MACHINE -ASSET NO OP-A02  
 CALIBRATED BY: QUALITY CONTROL TECHNOLOGY, CERT:- 4820 NEXT CAL DUE:- 13/10/07

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**UPSTREAM FACE INSPECTION RESULTS (ISO 5167)**

STATIONS	1	5	6	8				
FLATNESS $\mu$	0.184	0.017	0.217	0.133	0.213	0.111	0.190	0.325
'E' mm	6.430	6.344	6.324	6.395	6.340	6.282	6.322	6.414
'e' mm	4.296	4.115	4.112	4.312	4.262	4.172	4.236	4.312
EDGE SHARPNESS mm	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125
BEVEL ANGLE	37 DEGS							
CONCENTRICITY	0.715mm							
SURFACE FINISH (Ra)	0.9 microns							
DOWNSTREAM FACE/EDGE VISUAL INSPECTION	PASS							
ROUNDNESS	0.133mm	TAPER	0 degs					

COMMENTS:

INSPECTED BY



P. KENNERSON

**NATIONAL GRID ORIFICE PLATE CALIBRATION**

**DATE:** 11-OCT-2007  
**REF NO:** OP70102  
**TEMPERATURE:** 20 degsC

**MEASURED ORIFICE BORE:** 142.615mm

**PLATE DETAILS**

PLATE SERIAL. 215-6-1 PLATE O.D  
 MANUFACTURER: DANIEL PIPE I.D: mm SITE ECCLESTON FERRY  
 MATERIAL CERT.No 316SS DESIGN BORE mm FLOW 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:- 13/10/07

**UPSTREAM FACE INSPECTION RESULTS (ISO 5167)**

STATIONS	2	4	5	6	8			
FLATNESS %	0.004	0.057	0.047	0.166	0.057	0.096	0.008	0.014
mm	6.409	6.421	6.435	6.431	6.432	6.411	6.408	6.400
	4.615	4.667	4.708	4.694	4.714	4.696	4.616	4.594
EDGE SHARPNESS mm	SQUARE	SQUARE	SQUARE	0.0125	SQUARE	SQUARE	SQUARE	0.0125
BEVEL ANGLE	39 DEGS							
CONCENTRICITY	0.030mm							
SURFACE FINISH (Ra)	0.94 microns							
DOWNSTREAM FACE/EDGE VISUAL INSPECTION	PASS							
ROUNDNESS	0.005mm	TAPER.	0 degs					

**COMMENTS**

INSPECTED BY  M LIVINGSTONE

**NATIONAL GRID ORIFICE PLATE CALIBRATION**

**DATE:** 4-JULY-2008

**REF NO:** OP80034

**TEMPERATURE:** 20 degsC

**MEASURED ORIFICE BORE:** 142.612mm

PLATE DETAILS

PLATE SERIAL.	215-5	PLATE O.D	332.918mm	SITE:	ECCLESTON FERRY
MANUFACTURER:	DANIEL	PIPE I.D:	304.9969mm	FLOW:	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; CERT:- 6292 NEXT CAL DUE:- 05-OCTOBER-2008

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS:-	1	2	3	4	5	6	7	8
FLATNESS $\mu$	0.151	0.006	0.060	0.041	0.108	0.060	0.116	0.066
'E' mm	6.367	6.357	6.342	6.333	6.273	6.290	6.336	6.364
'e' mm	4.263	4.167	4.141	4.262	4.183	4.170	4.254	4.261
EDGE SHARPNESS mm	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125
BEVEL ANGLE:	37 DEGS							
CONCENTRICITY	0.620mm							
SURFACE FINISH (Ra)	0.6 microns							
DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS								
ROUNDNESS	0.009mm	TAPER:	0 degs					

DRAINHOLE PRESENT ? (YES/NO) No

COMMENTS: LIGHT GREASE U-STREAM

INSPECTED BY...  M Livingstone

## NATIONAL GRID ORIFICE PLATE CALIBRATION

**DATE:** 5-JUNE-2009

**REF NO:** OP90021

**TEMPERATURE:** 20.6 degsC

**MEASURED ORIFICE BORE:** 142.618mm

**PLATE DETAILS**

PLATE SERIAL:	215-6-1	PLATE O.D.	332.148mm	SITE:	ECCLESTON FERRY
MANUFACTURER:	DANIEL	PIPE I.D.:	304.9969mm	DESIGN BORE:	mm
MATERIAL CERT.NO	T7259 316			FLOW:	M <sup>3</sup> /DAY

**TEST EQUIPMENT**

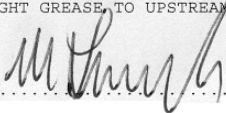
MANUFACTURER & TYPE: KEMCO 700 MANUAL 3-DIMENSIONAL MEASURING MACHINE -ASSET NO OP-A02  
 CALIBRATED BY: QUALITY CONTROL TECHNOLOGY, UKAS CERT:- 6822. NEXT CAL DUE:- 03-OCTOBER-2009

**UPSTREAM FACE INSPECTION RESULTS (ISO 5167)**

STATIONS:-	1	2	4	5	6	7	8	
FLATNESS %	0.014	0.075	0.049	0.073	0.025	0.084	0.010	0.006
E' mm	6.405	6.417	6.439	6.434	6.429	6.418	6.401	6.396
e' mm	4.618	4.652	4.706	4.694	4.699	4.700	4.612	4.580
EDGE SHARPNESS mm	SQUARE	0.025	SQUARE	SQUARE	SQUARE	0.025	SQUARE	0.0125
BEVEL ANGLE:	39 DEGS							
CONCENTRICITY	0.032mm							
SURFACE FINISH (Ra)	0.9 microns							
DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS								
ROUNDNESS	0.005mm	TAPER:	0 degs					

DRAINHOLE PRESENT ? (YES/NO): No

COMMENTS: LIGHT GREASE TO UPSTREAM

INSPECTED BY: 

M Livingstone



## APPENDIX B CORRECTED DAILY VOLUME FLOWS

TABLE B.1

### FLOWS AT ECCLESTON DURING THE PERIOD OF THE MIS-MEASUREMENT

	Original Values (total)	Corrected values (total)	% increase
Date	Volume (mscm)	Volume (mscm)	Volume (mscm)
27-Jun-07	0.0491	<b>0.04920</b>	0.2003
28-Jun-07	0.0000	<b>0.00000</b>	0.0000
29-Jun-07	0.0673	<b>0.06743</b>	0.2003
30-Jun-07	0.0000	<b>0.00000</b>	0.0000
01-Jul-07	0.0000	<b>0.00000</b>	0.0000
02-Jul-07	0.0479	<b>0.04800</b>	0.2003
03-Jul-07	0.0725	<b>0.07265</b>	0.2003
04-Jul-07	0.0000	<b>0.00000</b>	0.0000
05-Jul-07	0.0031	<b>0.00311</b>	0.2003
06-Jul-07	0.0000	<b>0.00000</b>	0.0000
07-Jul-07	0.0000	<b>0.00000</b>	0.0000
08-Jul-07	0.0000	<b>0.00000</b>	0.0000
09-Jul-07	0.0000	<b>0.00000</b>	0.0000
10-Jul-07	0.0238	<b>0.02385</b>	0.2003
11-Jul-07	0.0000	<b>0.00000</b>	0.0000
12-Jul-07	0.0000	<b>0.00000</b>	0.0000
13-Jul-07	0.0000	<b>0.00000</b>	0.0000
14-Jul-07	0.0000	<b>0.00000</b>	0.0000
15-Jul-07	0.0000	<b>0.00000</b>	0.0000
16-Jul-07	0.0000	<b>0.00000</b>	0.0000
17-Jul-07	0.0000	<b>0.00000</b>	0.0000
18-Jul-07	0.0000	<b>0.00000</b>	0.0000
19-Jul-07	0.0000	<b>0.00000</b>	0.0000
20-Jul-07	0.0000	<b>0.00000</b>	0.0000
21-Jul-07	0.0000	<b>0.00000</b>	0.0000
22-Jul-07	0.0000	<b>0.00000</b>	0.0000
23-Jul-07	0.0340	<b>0.03407</b>	0.2003
24-Jul-07	0.6637	<b>0.66503</b>	0.2003
25-Jul-07	0.8650	<b>0.86673</b>	0.2003
26-Jul-07	0.9024	<b>0.90421</b>	0.2003
27-Jul-07	0.8887	<b>0.89048</b>	0.2003
28-Jul-07	0.8338	<b>0.83547</b>	0.2003
29-Jul-07	0.8359	<b>0.83757</b>	0.2003
30-Jul-07	0.8928	<b>0.89459</b>	0.2003
31-Jul-07	0.8699	<b>0.87164</b>	0.2003
01-Aug-07	0.8622	<b>0.86393</b>	0.2003
02-Aug-07	0.8269	<b>0.82856</b>	0.2003
03-Aug-07	0.7728	<b>0.77435</b>	0.2003
04-Aug-07	0.7509	<b>0.75240</b>	0.2003

05-Aug-07	0.7299	<b>0.73136</b>	0.2003
06-Aug-07	0.8055	<b>0.80711</b>	0.2003
07-Aug-07	0.8721	<b>0.87385</b>	0.2003
08-Aug-07	0.8706	<b>0.87234</b>	0.2003
09-Aug-07	0.8462	<b>0.84789</b>	0.2003
10-Aug-07	0.8508	<b>0.85250</b>	0.2003
11-Aug-07	0.7336	<b>0.73507</b>	0.2003
12-Aug-07	0.7966	<b>0.79820</b>	0.2003
13-Aug-07	0.8697	<b>0.87144</b>	0.2003
14-Aug-07	0.8411	<b>0.84278</b>	0.2003
15-Aug-07	0.5930	<b>0.59419</b>	0.2003
16-Aug-07	0.0064	<b>0.00641</b>	0.2003
17-Aug-07	0.0000	<b>0.00000</b>	0.0000
18-Aug-07	0.0000	<b>0.00000</b>	0.0000
19-Aug-07	0.0096	<b>0.00962</b>	0.2003
20-Aug-07	0.0798	<b>0.07996</b>	0.2003
21-Aug-07	0.0000	<b>0.00000</b>	0.0000
22-Aug-07	0.0000	<b>0.00000</b>	0.0000
23-Aug-07	0.0000	<b>0.00000</b>	0.0000
24-Aug-07	0.0000	<b>0.00000</b>	0.0000
25-Aug-07	0.0000	<b>0.00000</b>	0.0000
26-Aug-07	0.0772	<b>0.07735</b>	0.2003
27-Aug-07	0.7926	<b>0.79419</b>	0.2003
28-Aug-07	0.8773	<b>0.87906</b>	0.2003
29-Aug-07	0.8873	<b>0.88908</b>	0.2003
30-Aug-07	0.8749	<b>0.87665</b>	0.2003
31-Aug-07	0.0000	<b>0.00000</b>	0.0000
01-Sep-07	0.0504	<b>0.05050</b>	0.2003
02-Sep-07	0.8521	<b>0.85381</b>	0.2003
03-Sep-07	0.0805	<b>0.08066</b>	0.2003
04-Sep-07	0.0000	<b>0.00000</b>	0.0000
05-Sep-07	0.2318	<b>0.23226</b>	0.2003
06-Sep-07	0.0000	<b>0.00000</b>	0.0000
07-Sep-07	0.0045	<b>0.00451</b>	0.2003
08-Sep-07	0.0000	<b>0.00000</b>	0.0000
09-Sep-07	0.0000	<b>0.00000</b>	0.0000
10-Sep-07	0.0000	<b>0.00000</b>	0.0000
11-Sep-07	0.2509	<b>0.25140</b>	0.2003
12-Sep-07	0.3618	<b>0.36252</b>	0.2003
13-Sep-07	0.0292	<b>0.02926</b>	0.2003
14-Sep-07	0.0219	<b>0.02194</b>	0.2003
15-Sep-07	0.0000	<b>0.00000</b>	0.0000
16-Sep-07	0.0000	<b>0.00000</b>	0.0000
17-Sep-07	0.0000	<b>0.00000</b>	0.0000
18-Sep-07	0.0000	<b>0.00000</b>	0.0000
19-Sep-07	0.0000	<b>0.00000</b>	0.0000
20-Sep-07	0.0000	<b>0.00000</b>	0.0000
21-Sep-07	0.0000	<b>0.00000</b>	0.0000

22-Sep-07	0.0000	<b>0.00000</b>	0.0000
23-Sep-07	0.0000	<b>0.00000</b>	0.0000
24-Sep-07	0.0000	<b>0.00000</b>	0.0000
25-Sep-07	0.0000	<b>0.00000</b>	0.0000
26-Sep-07	0.0000	<b>0.00000</b>	0.0000
27-Sep-07	0.0709	<b>0.07104</b>	0.2003
28-Sep-07	0.0000	<b>0.00000</b>	0.0000
29-Sep-07	0.0000	<b>0.00000</b>	0.0000
30-Sep-07	0.0000	<b>0.00000</b>	0.0000
01-Oct-07	0.0000	<b>0.00000</b>	0.0000
02-Oct-07	0.0000	<b>0.00000</b>	0.0000
03-Oct-07	0.0024	<b>0.00240</b>	0.2003
04-Oct-07	0.2564	<b>0.25691</b>	0.2003
05-Oct-07	0.0000	<b>0.00000</b>	0.0000
06-Oct-07	0.0000	<b>0.00000</b>	0.0000
07-Oct-07	0.0000	<b>0.00000</b>	0.0000
08-Oct-07	0.0000	<b>0.00000</b>	0.0000
09-Oct-07	0.0000	<b>0.00000</b>	0.0000
10-Oct-07	0.0000	<b>0.00000</b>	0.0000
11-Oct-07	0.0000	<b>0.00000</b>	0.0000
12-Oct-07	0.0000	<b>0.00000</b>	0.0000
13-Oct-07	0.0000	<b>0.00000</b>	0.0000
14-Oct-07	0.0000	<b>0.00000</b>	0.0000
15-Oct-07	0.0000	<b>0.00000</b>	0.0000
16-Oct-07	0.0000	<b>0.00000</b>	0.0000
17-Oct-07	0.8623	<b>0.86403</b>	0.2003
18-Oct-07	0.4933	<b>0.49429</b>	0.2003
19-Oct-07	0.2581	<b>0.25862</b>	0.2003
20-Oct-07	0.0000	<b>0.00000</b>	0.0000
21-Oct-07	0.0000	<b>0.00000</b>	0.0000
22-Oct-07	0.7527	<b>0.75421</b>	0.2003
23-Oct-07	0.5674	<b>0.56854</b>	0.2003
24-Oct-07	0.7306	<b>0.73206</b>	0.2003
25-Oct-07	0.8752	<b>0.87695</b>	0.2003
26-Oct-07	0.7922	<b>0.79379</b>	0.2003
27-Oct-07	0.6329	<b>0.63417</b>	0.2003
28-Oct-07	0.6746	<b>0.67595</b>	0.2003
29-Oct-07	0.7769	<b>0.77846</b>	0.2003
30-Oct-07	0.7022	<b>0.70361</b>	0.2003
31-Oct-07	0.6844	<b>0.68577</b>	0.2003
01-Nov-07	0.6235	<b>0.62475</b>	0.2003
02-Nov-07	0.5988	<b>0.60000</b>	0.2003
03-Nov-07	0.7425	<b>0.74399</b>	0.2003
04-Nov-07	0.7251	<b>0.72655</b>	0.2003
05-Nov-07	0.6040	<b>0.60521</b>	0.2003
06-Nov-07	0.7429	<b>0.74439</b>	0.2003
07-Nov-07	0.7906	<b>0.79218</b>	0.2003
08-Nov-07	0.9819	<b>0.98387</b>	0.2003

09-Nov-07	1.1987	<b>1.20110</b>	0.2003
10-Nov-07	1.0113	<b>1.01333</b>	0.2003
11-Nov-07	1.0300	<b>1.03206</b>	0.2003
12-Nov-07	1.1854	<b>1.18777</b>	0.2003
13-Nov-07	1.1811	<b>1.18347</b>	0.2003
14-Nov-07	1.3249	<b>1.32755</b>	0.2003
15-Nov-07	1.4201	<b>1.42294</b>	0.2003
16-Nov-07	1.3771	<b>1.37986</b>	0.2003
17-Nov-07	1.2054	<b>1.20781</b>	0.2003
18-Nov-07	1.4137	<b>1.41653</b>	0.2003
19-Nov-07	1.2089	<b>1.21131</b>	0.2003
20-Nov-07	0.8940	<b>0.89579</b>	0.2003
21-Nov-07	0.9199	<b>0.92174</b>	0.2003
22-Nov-07	1.0484	<b>1.05050</b>	0.2003
23-Nov-07	1.2177	<b>1.22014</b>	0.2003
24-Nov-07	1.1250	<b>1.12725</b>	0.2003
25-Nov-07	0.9445	<b>0.94639</b>	0.2003
26-Nov-07	0.8811	<b>0.88286</b>	0.2003
27-Nov-07	0.8380	<b>0.83968</b>	0.2003
28-Nov-07	0.8833	<b>0.88506</b>	0.2003
29-Nov-07	0.9507	<b>0.95261</b>	0.2003
30-Nov-07	0.6682	<b>0.66954</b>	0.2003
01-Dec-07	0.7095	<b>0.71092</b>	0.2003
02-Dec-07	0.6468	<b>0.64810</b>	0.2003
03-Dec-07	1.0357	<b>1.03777</b>	0.2003
04-Dec-07	0.9161	<b>0.91794</b>	0.2003
05-Dec-07	0.9406	<b>0.94248</b>	0.2003
06-Dec-07	0.6185	<b>0.61974</b>	0.2003
07-Dec-07	0.8557	<b>0.85741</b>	0.2003
08-Dec-07	0.9425	<b>0.94439</b>	0.2003
09-Dec-07	0.9519	<b>0.95381</b>	0.2003
10-Dec-07	1.1711	<b>1.17345</b>	0.2003
11-Dec-07	1.1788	<b>1.18116</b>	0.2003
12-Dec-07	1.1806	<b>1.18296</b>	0.2003
13-Dec-07	1.3389	<b>1.34158</b>	0.2003
14-Dec-07	1.3154	<b>1.31803</b>	0.2003
15-Dec-07	1.2771	<b>1.27966</b>	0.2003
16-Dec-07	1.3107	<b>1.31333</b>	0.2003
17-Dec-07	1.3758	<b>1.37856</b>	0.2003
18-Dec-07	1.2308	<b>1.23327</b>	0.2003
19-Dec-07	1.3228	<b>1.32545</b>	0.2003
20-Dec-07	1.3811	<b>1.38387</b>	0.2003
21-Dec-07	1.4763	<b>1.47926</b>	0.2003
22-Dec-07	1.2253	<b>1.22775</b>	0.2003
23-Dec-07	1.1407	<b>1.14298</b>	0.2003
24-Dec-07	0.7558	<b>0.75731</b>	0.2003
25-Dec-07	0.7915	<b>0.79309</b>	0.2003
26-Dec-07	0.7426	<b>0.74409</b>	0.2003

27-Dec-07	0.8591	<b>0.86082</b>	0.2003
28-Dec-07	0.8814	<b>0.88317</b>	0.2003
29-Dec-07	0.8862	<b>0.88798</b>	0.2003
30-Dec-07	0.9018	<b>0.90361</b>	0.2003
31-Dec-07	0.9520	<b>0.95391</b>	0.2003
01-Jan-08	0.8806	<b>0.88236</b>	0.2003
02-Jan-08	1.1913	<b>1.19369</b>	0.2003
03-Jan-08	1.3535	<b>1.35621</b>	0.2003
04-Jan-08	1.2627	<b>1.26523</b>	0.2003
05-Jan-08	1.0630	<b>1.06513</b>	0.2003
06-Jan-08	1.1302	<b>1.13246</b>	0.2003
07-Jan-08	1.2186	<b>1.22104</b>	0.2003
08-Jan-08	1.1831	<b>1.18547</b>	0.2003
09-Jan-08	1.2167	<b>1.21914</b>	0.2003
10-Jan-08	1.0709	<b>1.07305</b>	0.2003
11-Jan-08	1.2274	<b>1.22986</b>	0.2003
12-Jan-08	1.0922	<b>1.09439</b>	0.2003
13-Jan-08	0.9843	<b>0.98627</b>	0.2003
14-Jan-08	1.0633	<b>1.06543</b>	0.2003
15-Jan-08	1.0485	<b>1.05060</b>	0.2003
16-Jan-08	1.0750	<b>1.07715</b>	0.2003
17-Jan-08	1.1187	<b>1.12094</b>	0.2003
18-Jan-08	0.9734	<b>0.97535</b>	0.2003
19-Jan-08	0.9322	<b>0.93407</b>	0.2003
20-Jan-08	0.8592	<b>0.86092</b>	0.2003
21-Jan-08	0.9758	<b>0.97775</b>	0.2003
22-Jan-08	1.0843	<b>1.08647</b>	0.2003
23-Jan-08	0.9096	<b>0.91142</b>	0.2003
24-Jan-08	1.0069	<b>1.00892</b>	0.2003
25-Jan-08	1.0434	<b>1.04549</b>	0.2003
26-Jan-08	0.9044	<b>0.90621</b>	0.2003
27-Jan-08	0.9685	<b>0.97044</b>	0.2003
28-Jan-08	0.9807	<b>0.98266</b>	0.2003
29-Jan-08	1.0042	<b>1.00621</b>	0.2003
30-Jan-08	1.1020	<b>1.10421</b>	0.2003
31-Jan-08	1.1903	<b>1.19268</b>	0.2003
01-Feb-08	1.2798	<b>1.28236</b>	0.2003
02-Feb-08	1.1808	<b>1.18317</b>	0.2003
03-Feb-08	1.1487	<b>1.15100</b>	0.2003
04-Feb-08	1.1309	<b>1.13317</b>	0.2003
05-Feb-08	1.0000	<b>1.00200</b>	0.2003
06-Feb-08	1.0791	<b>1.08126</b>	0.2003
07-Feb-08	0.9810	<b>0.98296</b>	0.2003
08-Feb-08	0.9898	<b>0.99178</b>	0.2003
09-Feb-08	0.9843	<b>0.98627</b>	0.2003
10-Feb-08	1.0499	<b>1.05200</b>	0.2003
11-Feb-08	1.0371	<b>1.03918</b>	0.2003
12-Feb-08	0.9827	<b>0.98467</b>	0.2003

13-Feb-08	1.0452	<b>1.04729</b>	0.2003
14-Feb-08	1.1950	<b>1.19739</b>	0.2003
15-Feb-08	1.1941	<b>1.19649</b>	0.2003
16-Feb-08	1.0512	<b>1.05331</b>	0.2003
17-Feb-08	0.7969	<b>0.79850</b>	0.2003
18-Feb-08	1.1306	<b>1.13286</b>	0.2003
19-Feb-08	1.3059	<b>1.30852</b>	0.2003
20-Feb-08	1.2817	<b>1.28427</b>	0.2003
21-Feb-08	1.0999	<b>1.10210</b>	0.2003
22-Feb-08	0.9018	<b>0.90361</b>	0.2003
23-Feb-08	0.8820	<b>0.88377</b>	0.2003
24-Feb-08	0.9777	<b>0.97966</b>	0.2003
25-Feb-08	1.0878	<b>1.08998</b>	0.2003
26-Feb-08	0.9921	<b>0.99409</b>	0.2003
27-Feb-08	1.0453	<b>1.04739</b>	0.2003
28-Feb-08	1.0586	<b>1.06072</b>	0.2003
29-Feb-08	1.0603	<b>1.06242</b>	0.2003
01-Mar-08	0.9721	<b>0.97405</b>	0.2003
02-Mar-08	0.9012	<b>0.90301</b>	0.2003
03-Mar-08	1.0991	<b>1.10130</b>	0.2003
04-Mar-08	1.1349	<b>1.13717</b>	0.2003
05-Mar-08	1.1102	<b>1.11242</b>	0.2003
06-Mar-08	1.0316	<b>1.03367</b>	0.2003
07-Mar-08	0.9231	<b>0.92495</b>	0.2003
08-Mar-08	0.9372	<b>0.93908</b>	0.2003
09-Mar-08	0.9690	<b>0.97094</b>	0.2003
10-Mar-08	1.1851	<b>1.18747</b>	0.2003
11-Mar-08	1.0943	<b>1.09649</b>	0.2003
12-Mar-08	1.1214	<b>1.12365</b>	0.2003
13-Mar-08	1.0398	<b>1.04188</b>	0.2003
14-Mar-08	0.9695	<b>0.97144</b>	0.2003
15-Mar-08	0.9634	<b>0.96533</b>	0.2003
16-Mar-08	0.9965	<b>0.99850</b>	0.2003
17-Mar-08	1.0499	<b>1.05200</b>	0.2003
18-Mar-08	1.0846	<b>1.08677</b>	0.2003
19-Mar-08	1.0131	<b>1.01513</b>	0.2003
20-Mar-08	1.0326	<b>1.03467</b>	0.2003
21-Mar-08	1.0164	<b>1.01844</b>	0.2003
22-Mar-08	1.0472	<b>1.04930</b>	0.2003
23-Mar-08	0.9977	<b>0.99970</b>	0.2003
24-Mar-08	1.1104	<b>1.11262</b>	0.2003
25-Mar-08	1.1006	<b>1.10280</b>	0.2003
26-Mar-08	0.9287	<b>0.93056</b>	0.2003
27-Mar-08	1.0365	<b>1.03858</b>	0.2003
28-Mar-08	1.0373	<b>1.03938</b>	0.2003
29-Mar-08	0.9828	<b>0.98477</b>	0.2003
30-Mar-08	0.8440	<b>0.84569</b>	0.2003
31-Mar-08	0.9035	<b>0.90531</b>	0.2003

01-Apr-08	0.7516	<b>0.75311</b>	0.2003
02-Apr-08	0.9178	<b>0.91964</b>	0.2003
03-Apr-08	0.8445	<b>0.84619</b>	0.2003
04-Apr-08	0.7599	<b>0.76142</b>	0.2003
05-Apr-08	0.8849	<b>0.88667</b>	0.2003
06-Apr-08	1.0052	<b>1.00721</b>	0.2003
07-Apr-08	1.0526	<b>1.05471</b>	0.2003
08-Apr-08	1.0680	<b>1.07013</b>	0.2003
09-Apr-08	1.0269	<b>1.02896</b>	0.2003
10-Apr-08	1.0021	<b>1.00412</b>	0.2003
11-Apr-08	0.9764	<b>0.97836</b>	0.2003
12-Apr-08	0.9153	<b>0.91713</b>	0.2003
13-Apr-08	0.9026	<b>0.90441</b>	0.2003
14-Apr-08	0.9164	<b>0.91824</b>	0.2003
15-Apr-08	0.9453	<b>0.94719</b>	0.2003
16-Apr-08	0.9761	<b>0.97806</b>	0.2003
17-Apr-08	0.9869	<b>0.98888</b>	0.2003
18-Apr-08	1.0122	<b>1.01423</b>	0.2003
19-Apr-08	0.9870	<b>0.98898</b>	0.2003
20-Apr-08	0.9513	<b>0.95321</b>	0.2003
21-Apr-08	0.8117	<b>0.81333</b>	0.2003
22-Apr-08	0.7031	<b>0.70451</b>	0.2003
23-Apr-08	0.0110	<b>0.01102</b>	0.2003
24-Apr-08	0.0273	<b>0.02735</b>	0.2003
25-Apr-08	0.0000	<b>0.00000</b>	0.0000
26-Apr-08	0.0000	<b>0.00000</b>	0.0000
27-Apr-08	0.0000	<b>0.00000</b>	0.0000
28-Apr-08	0.0000	<b>0.00000</b>	0.0000
29-Apr-08	0.0001	<b>0.00010</b>	0.2003
30-Apr-08	0.0000	<b>0.00000</b>	0.0000
01-May-08	0.0000	<b>0.00000</b>	0.0000
02-May-08	0.0000	<b>0.00000</b>	0.0000
03-May-08	0.0000	<b>0.00000</b>	0.0000
04-May-08	0.0000	<b>0.00000</b>	0.0000
05-May-08	0.0000	<b>0.00000</b>	0.0000
06-May-08	0.0065	<b>0.00651</b>	0.2003
07-May-08	0.0000	<b>0.00000</b>	0.0000
08-May-08	0.0000	<b>0.00000</b>	0.0000
09-May-08	0.0000	<b>0.00000</b>	0.0000
10-May-08	0.0000	<b>0.00000</b>	0.0000
11-May-08	0.0129	<b>0.01293</b>	0.2003
12-May-08	0.0000	<b>0.00000</b>	0.0000
13-May-08	0.0000	<b>0.00000</b>	0.0000
14-May-08	0.0000	<b>0.00000</b>	0.0000
15-May-08	0.0000	<b>0.00000</b>	0.0000
16-May-08	0.0000	<b>0.00000</b>	0.0000
17-May-08	0.0000	<b>0.00000</b>	0.0000
18-May-08	0.0000	<b>0.00000</b>	0.0000

19-May-08	0.0000	<b>0.00000</b>	0.0000
20-May-08	0.0143	<b>0.01433</b>	0.2003
21-May-08	0.0000	<b>0.00000</b>	0.0000
22-May-08	0.0425	<b>0.04259</b>	0.2003
23-May-08	0.0231	<b>0.02315</b>	0.2003
24-May-08	0.0000	<b>0.00000</b>	0.0000
25-May-08	0.0000	<b>0.00000</b>	0.0000
26-May-08	0.0000	<b>0.00000</b>	0.0000
27-May-08	0.0000	<b>0.00000</b>	0.0000
28-May-08	0.0000	<b>0.00000</b>	0.0000
29-May-08	0.0000	<b>0.00000</b>	0.0000
30-May-08	0.0000	<b>0.00000</b>	0.0000
31-May-08	0.0000	<b>0.00000</b>	0.0000
01-Jun-08	0.0000	<b>0.00000</b>	0.0000
02-Jun-08	0.0000	<b>0.00000</b>	0.0000
03-Jun-08	0.0000	<b>0.00000</b>	0.0000
04-Jun-08	0.0000	<b>0.00000</b>	0.0000
05-Jun-08	0.0000	<b>0.00000</b>	0.0000
06-Jun-08	0.0000	<b>0.00000</b>	0.0000
07-Jun-08	0.0000	<b>0.00000</b>	0.0000
08-Jun-08	0.0000	<b>0.00000</b>	0.0000
09-Jun-08	0.0000	<b>0.00000</b>	0.0000
10-Jun-08	0.0052	<b>0.00521</b>	0.2003
11-Jun-08	0.0000	<b>0.00000</b>	0.0000
12-Jun-08	0.0000	<b>0.00000</b>	0.0000
13-Jun-08	0.0000	<b>0.00000</b>	0.0000
14-Jun-08	0.0000	<b>0.00000</b>	0.0000
15-Jun-08	0.0000	<b>0.00000</b>	0.0000
16-Jun-08	0.0000	<b>0.00000</b>	0.0000
17-Jun-08	0.0000	<b>0.00000</b>	0.0000
18-Jun-08	0.0000	<b>0.00000</b>	0.0000
19-Jun-08	0.0000	<b>0.00000</b>	0.0000
20-Jun-08	0.0145	<b>0.01450</b>	0.0000