



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

A Report for

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

PROJECT NO: NGR010

REPORT NO: 2010/289

DATE: 18 AUGUST 2010



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

## **NOTES**

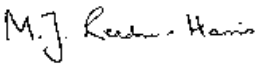
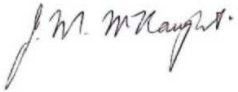
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## Assessment of Error Due to Orifice Diameter Mis-Measurement at Mickle Trafford

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: 18 August 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 Mickle Trafford a correction factor of 1.002004 should be applied during the period of mis-measurement.

Over the period 04/10/2007 to 27/08/08 inclusive the flow was 331.99686 mscm and the corrected flow should be 332.66156 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 Mickle Trafford in the period of the error. The Joint Office Error Code is NW005.

## 2 ORIFICE DIAMETERS

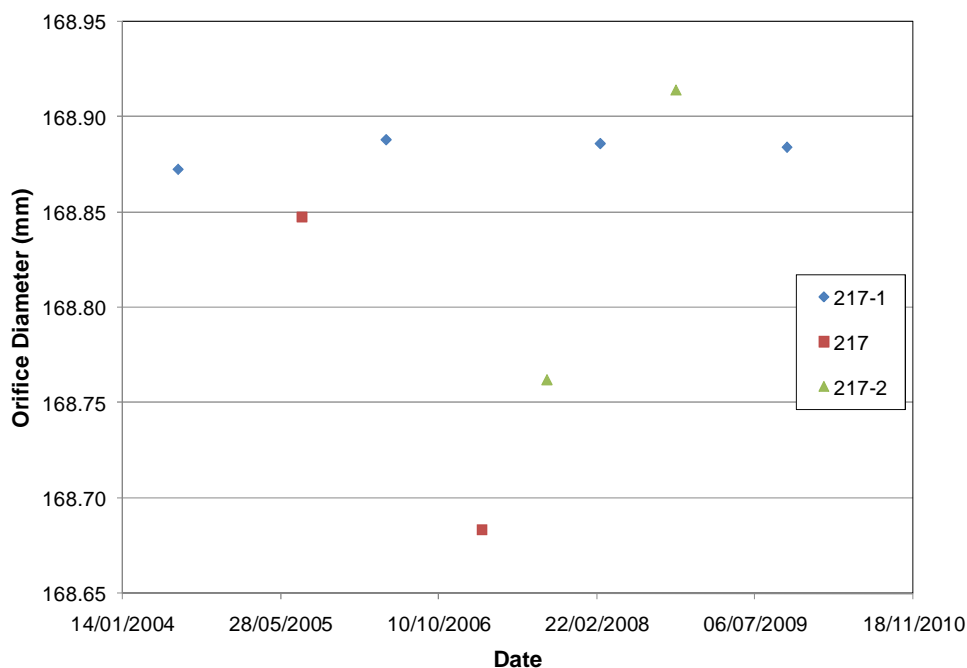
The calibrations of the orifice plates in question gave the measured diameters shown in Table 1. The diameters at 20 °C have been calculated.

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

Calibration Reference	Plate serial no	Declared certificate date	Orifice bore (mm)	Temperature	Value at 20 °C Orifice bore (mm)
OP4074	217-1	09/07/2004	168.8755	21	168.8728
OP50095	217	02/08/2005	168.8500	21	168.8473
OP60053	217-1	27/04/2006	168.8880	20	168.8880
OP70014	217	22/02/2007	168.6860	21	168.6833
OP70093	217-2	18/09/2007	168.7620	20	168.7620
OP80007	217-1	03/03/2008	168.8860	20	168.8860
OP80073	217-2	29/10/2008	168.9155	20.5	168.9141
OP90041	217-1	14/10/2009	168.8855	20.5	168.8841

Figure 1 shows the data from Table 1 for the orifice bores at 20°C. This figure shows that for plate 217 there is a high measurement followed by a low measurement of diameter and for plate 217-2 there is a low measurement followed by a high measurement of diameter. The deduction from this graph is that plates were mis-measured. From the experience of other sets of measurements it is the low measurements that are in error.

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	Not Given	Not Given	Not Given	Not Given
	27/09/2007 11:55	04/10/2007 11:39	27/08/2008 (From HPMIS)	05/03/2009 12:01
Orifice plate bore diameter (mm)	168.8880005	168.7619934	168.886	168.8860016
Expansion coefficient of the plate (1/°C)	0.000016	0.000016		0.000016
Orifice plate calibration temperature	20	20	20	20
Meter tube diameter (mm)	304.7576904	304.7576904		304.7576904
Expansion coefficient of the meter tube (1/°C)	0.000011	0.000011		0.000011
Meter tube calibration temperature	15	15		15
Isentropic Exponent	1.3418	1.3418		1.3464
Dynamic Viscosity (Pa.s)	0.0000122	0.0000122		0.0000121
Orifice plate certificate number	OP60053	OP70093	OP80007	OP80007
Orifice plate serial number	217-1	217-2	217-1	217-1
Error in orifice diameter?	No	Yes	No	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 seven-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:

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

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  $\varepsilon$  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 0.00002% at maximum.

Over the period from 04/10/2007 to 27/08/2008 the correction can be calculated as in Table 3; throughout this calculation the meter tube diameter is 304.7577 mm at 15°C, the isentropic exponent is 1.3418 and the dynamic viscosity 0.0000122 Pa s. At Mickle Trafford the meter tube calibration temperature was 15°C rather than 20°C at the other sites. Therefore the thermal expansion to 20°C has been taken into account in the calculation of the correction factors at Mickle Trafford.

**TABLE 3**  
**THE CORRECTION FROM 04/10/2007 TO 27/08/2008**

	$d$ mm	$\beta$	$\varepsilon$	$Re_D$	$C$	$\frac{q_{m,c}}{q_{m,o}}$
Original: $\Delta p=10$ mbar	168.762	0.553728	0.999944	1592969	0.604059	
Corrected $\Delta p=10$ mbar	168.91415	0.554227	0.999944	1596161	0.604067	1.0020041
Original $\Delta p=500$ mbar	168.762	0.553728	0.997203	11226434	0.603700	
Corrected $\Delta p=500$ mbar	168.91415	0.554227	0.997202	11248920	0.603708	1.0020029

So  $q_{m,c}/q_{m,o}$  is 1.002004.

#### 4 CORRECTIONS ON A DAILY BASIS

The volume flows for each day from 04/10/2007 to 27/08/2008 are given in Table B.1 of Appendix B together with the corrected values. It has been assumed that the plates were changed at 11:00; therefore 78.8% of the flow for 04/10/2007 has to be corrected and 28.4% of that for 27/08/08 has to be corrected based on the proportion before and after 11:00. Summing the data gives the figures in Table 4.

**TABLE 4**  
**THE FLOW OVER THE PERIOD 04/10/2007 TO 27/08/2008 INCLUSIVE**

Flow (mscm)	331.99686
Correction (mscm)	0.66470
Corrected flow (mscm)	332.66156
% Change	0.2002

#### 5 CONCLUSIONS

A correction factor of 1.002004 should be applied during the period of mis-measurement.



**APPENDIX A  
ORIFICE PLATE CALIBRATION CERTIFICATES**

**TRANSCO ORIFICE PLATE CALIBRATION**

**DATE:** 09-07-04  
**REF NO:** OP4074  
**TEMPERATURE:** 21 degsC  
**MEASURED ORIFICE BORE:** 168.8755mm

PLATE DETAILS

PLATE SERIAL: 217-1      PLATE O.D: 355.556mm  
 MANUFACTURER:      PIPE I.D: 304.8mm      SITE: MICKLE TRAFFORD  
 MATERIAL CERT.No.      DESIGN BORE: 168.907mm      FLOW: 2880000 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:- 3858      NEXT CAL DUE:- 17/10/04

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS :-	1	2	3	4	5	6	7	8
FLATNESS %	0.043	0.058	0.087	0.071	0.126	0.047	0.064	0.054
'E' mm	6.338	6.336	6.328	6.327	6.338	6.343	6.329	6.338
'e' mm	5.005	4.983	4.952	4.936	4.965	4.957	4.950	5.039
EDGE SHARPNESS mm	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125
CONCENTRICITY	0.047mm							
SURFACE FINISH (Ra)	1.1 microns							

DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS

ROUNDNESS 0.011mm      TAPER: 0 degs

BEVEL ANGLE: 37DEGS

COMMENTS:

INSPECTED BY  G. WARDLE

VERIFIED BY  P. KENNERSON

**NATIONAL GRID ORIFICE PLATE CALIBRATION**

**DATE:** 02-08-05  
**REF NO:** OP50095  
**TEMPERATURE:** 21 degsC  
**MEASURED ORIFICE BORE:** 168.85mm

PLATE DETAILS

PLATE SERIAL. 217 PLATE O.D 355.610mm  
 MANUFACTURER: PIPE I.D: 304.8mm SITE: MICKLE TRAFFORD  
 MATERIAL CERT.No DESIGN BORE: 168.907mm FLOW: 2.88X10E06 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	7	8
FLATNESS $\mu$	0.144	0.096	0.075	0.119	0.129	0.117	0.070	0.093
E' mm	6.337	6.325	6.317	6.310	6.303	6.319	6.327	6.337
e' mm	4.911	4.921	4.882	4.843	4.841	4.839	4.849	4.881
EDGE SHARPNESS mm	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125
BEVEL ANGLE	37 DEGS							
CONCENTRICITY	0.053mm							
SURFACE FINISH (Ra)	2.3 microns							

DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS

ROUNDNESS : 0.007mm TAPER: 0 degs

COMMENTS

INSPECTED BY  P. KENNERSON

**NATIONAL GRID ORIFICE PLATE CALIBRATION**

**DATE:** 27-04-06  
**REF NO:** OP60053  
**TEMPERATURE:** 20 degsC

**MEASURED ORIFICE BORE:** 168.888mm

**PLATE DETAILS**

PLATE SERIAL.	217-1	PLATE O.D	355.578mm	SITE	MICKLE TRAFFORD
MANUFACTURER:		PIPE I.D:	304.8mm	FLOW	2.880000 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-A0  
 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 $\mu$	0.033	0.075	0.067	0.084	0.068	0.047	0.053	0.047
'E		6.339	6.340	6.328	6.337	6.347	6.340	6.340
'e' mm	4.990	5.014	4.961	4.951	4.955	4.962	4.984	5.003
EDGE SHARPNESS mm	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125
BEVEL ANGLE	37 DEGS							
CONCENTRICITY	0.074mm							
SURFACE FINISH (Ra)	1.0 microns							
DOWNSTREAM FACE/EDGE VISUAL INSPECTION	PASS							
ROUNDNESS	0.004mm	TAPER	0 degs					

**COMMENTS**

INSPECTED BY

 P. KENNERSON  J. CHAUHAN

**NATIONAL GRID ORIFICE PLATE CALIBRATION**

**DATE:** 22-02-07  
**REF NO:** OP70014  
**TEMPERATURE:** 21 degsC

**MEASURED ORIFICE BORE:** 168.686mm

**PLATE DETAILS**

PLATE SERIAL:	217	PLATE O.D	355.330mm	SITE:	MICKLE TRAFFORD
MANUFACTURER:		PIPE I.D:	304.8mm	FLOW:	2.88X10E06 M <sup>3</sup> /DAY
MATERIAL CERT.No		DESIGN BORE	168.907mm		

**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 $\mu$	0.145	0.121	0.078	0.120	0.121	0.107	0.084	0.100
SE mm	6.386	6.298	6.302	6.362	6.361	6.302	6.312	6.387
TE mm	4.964	4.911	4.875	4.887	4.881	4.820	4.868	4.937
EDGE SHARPNESS mm	SQUARE	SQUARE	SQUARE	0.0125	SQUARE	SQUARE	0.0125	0.0125
BEVEL ANGLE:	37 DEGS							
CONCENTRICITY	0.032mm							
SURFACE FINISH (Ra)	1.7 microns							
DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS								
ROUNDNESS	0.157mm	TAPER	0 degs					

**COMMENTS**

INSPECTED BY: *P. Kennerson* P. KENNERSON

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 18-SEPT-2007  
 REF NO: OP70093  
 TEMPERATURE: 20 degsC

MEASURED ORIFICE BORE: 168.762mm

PLATE DETAILS

PLATE SERIAL. 217-2 PLATE O.D 355.335mm  
 MANUFACTURER: ANT PIPE I.D: mm SITE MICKLE TRAFFORD  
 MATERIAL CERT.No SS316 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 $\mu$	0.031	0.041	0.041	0.051	0.028	0.042	0.021	0.020
mm	6.385	6.320	6.326	6.375	6.388	6.333	6.332	6.387
	4.844	4.992	4.805	4.806	4.895	4.897	4.824	4.896
EDGE SHARPNESS mm	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
BEVEL ANGLE	43 DEGS							
CONCENTRICITY	0.033mm							
SURFACE FINISH (Ra)	1.0 microns							
DOWNSTREAM FACE/EDGE VISUAL INSPECTION	PASS							
ROUNDNESS 0.161mm	TAPER 0 degs							

COMMENTS

INSPECTED BY  M LIVINGSTONE

BRIAN DAVIES 07774973768

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 03-MAR-2008

REF NO: OP80007

TEMPERATURE: 20 degsC

MEASURED ORIFICE BORE: 168.886mm

PLATE DETAILS

PLATE SERIAL: 217-1 PLATE O.D: 355.565mm  
 MANUFACTURER: PIPE I.D: 304.7577mm SITE: MICKLE TRAFFORD  
 MATERIAL CERT.No: DESIGN BORE: mm FLOW: 2.880000 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	7		
FLATNESS %	0.020	0.113	0.068	0.018	0.099	0.042	0.033	0.035
E' mm	6.333	6.334	6.335	6.316	6.326	6.347	6.337	6.330
mm	5.035	4.980	4.960	4.850	4.947	4.956	4.979	5.012
EDGE SHARPNESS mm	0.0125	0.025	0.025	0.0125	SQUARE	0.0125	SQUARE	SQUARE
BEVEL ANGLE:	37 DEGS							
CONCENTRICITY	0.069mm							
SURFACE FINISH (Ra)	0.85 microns							

DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS

ROUNDNESS : 0.009mm TAPER: 0 degs

COMMENTS: CLEAN PLATE

INSPECTED BY:  M Livingstone.

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 29-OCT-2008

REF NO: OP80073

TEMPERATURE: 20.5 degsC

MEASURED ORIFICE BORE: 168.9155mm

PLATE DETAILS

PLATE SERIAL.	2172	PLATE O.D		SITE	MICKLE TRAFFORD
MANUFACTURER:		PIPE I.D:	304.8mm	FLOW	2.880000 M <sup>3</sup> /DAY
MATERIAL CERT.No		DESIGN BORE	mm		

TEST EQUIPMENT

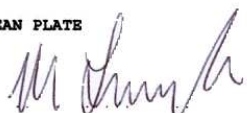
MANUFACTURER & TYPE: KEMCO 700 MANUAL 3-DIMENSIONAL MEASURING MACHINE -ASSET NO OP-A02  
 CALIBRATED BY: QUALITY CONTROL TECHNOLOGY, UKAS CERT:- 6822. NEXT CAL DUE:- 03-OCTOBER-2009

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS	2	5	8
FLATNESS $\mu$	0.035	0.037	0.021
	6.337	6.324	6.328
	4.802	4.818	4.810
	4.805	4.813	4.813
	4.849	4.813	4.813
EDGE SHARPNESS mm	0.025	0.025	0.025
BEVEL ANGLE	44 DEGS		
CONCENTRICITY	0.011mm		
SURFACE FINISH (Ra)	1.0 microns		
DOWNSTREAM FACE/EDGE VISUAL INSPECTION	PASS		
ROUNDNESS	0.017mm	TAPER	0 degs

DRAINHOLE PRESENT ? (YES/NO) No

COMMENTS: CLEAN PLATE

INSPECTED BY  M Livingstone

**NATIONAL GRID ORIFICE PLATE CALIBRATION**

**DATE:** 14-OCT-2009

**REF NO:** OP90041

**TEMPERATURE:** 20.5 degsC

**MEASURED ORIFICE BORE:** 168.8855mm

PLATE DETAILS

PLATE SERIAL.	217-1	PLATE O.D	355.557mm		
MANUFACTURER:		PIPE I.D:	304.7577mm	SITE	MICKLE TRAFFORD
MATERIAL CERT.No		DESIGN BORE	mm	FLOW	2.880000 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 TRACEABLE CERT:- 7325. NEXT CAL DUE:- 02-OCTOBER-2010

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS:	1	2						8
FLATNESS %	0.036	0.078	0.055	0.048	0.113	0.059	0.037	
E mm	6.339	6.345	6.343	6.319	6.338	6.346	6.338	
mm	5.009	4.989	4.976	4.935	4.953	4.952		
EDGE SHARPNESS mm	0.0125	0.0125	0.025	0.0125	0.0125	SQUARE	SQUARE	
BEVEL ANGLE	37 DEGS							
CONCENTRICITY	0.054mm							
SURFACE FINISH (Ra)	0.78 microns							
DOWNSTREAM FACE/EDGE VISUAL INSPECTION	PASS							
ROUNDNESS 0.005mm 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 MICKLE TRAFFORD DURING THE PERIOD OF THE MIS-MEASUREMENT

	Original Values (total)	Corrected values (total)	% increase
Date	Volume (mscm)	Volume (mscm)	Volume (mscm)
04-Oct-07	1.3846	<b>1.38679</b>	0.1578
05-Oct-07	1.5728	<b>1.57595</b>	0.2004
06-Oct-07	1.4566	<b>1.45952</b>	0.2004
07-Oct-07	1.5034	<b>1.50641</b>	0.2004
08-Oct-07	1.5856	<b>1.58878</b>	0.2004
09-Oct-07	1.6082	<b>1.61142</b>	0.2004
10-Oct-07	1.6992	<b>1.70261</b>	0.2004
11-Oct-07	1.6419	<b>1.64519</b>	0.2004
12-Oct-07	1.4196	<b>1.42244</b>	0.2004
13-Oct-07	1.3191	<b>1.32174</b>	0.2004
14-Oct-07	1.3667	<b>1.36944</b>	0.2004
15-Oct-07	1.5217	<b>1.52475</b>	0.2004
16-Oct-07	1.7542	<b>1.75772</b>	0.2004
17-Oct-07	1.0933	<b>1.09549</b>	0.2004
18-Oct-07	1.6126	<b>1.61583</b>	0.2004
19-Oct-07	1.7632	<b>1.76673</b>	0.2004
20-Oct-07	1.9896	<b>1.99359</b>	0.2004
21-Oct-07	1.9468	<b>1.95070</b>	0.2004
22-Oct-07	1.511	<b>1.51403</b>	0.2004
23-Oct-07	1.583	<b>1.58617</b>	0.2004
24-Oct-07	1.5931	<b>1.59629</b>	0.2004
25-Oct-07	1.30679	<b>1.30941</b>	0.2004
26-Oct-07	1.3253	<b>1.32796</b>	0.2004
27-Oct-07	1.2553	<b>1.25782</b>	0.2004
28-Oct-07	1.0679	<b>1.07004</b>	0.2004
29-Oct-07	1.3976	<b>1.40040</b>	0.2004
30-Oct-07	1.3748	<b>1.37756</b>	0.2004
31-Oct-07	1.22469	<b>1.22714</b>	0.2004
01-Nov-07	1.20831	<b>1.21073</b>	0.2004
02-Nov-07	1.1035	<b>1.10571</b>	0.2004
03-Nov-07	1.07069	<b>1.07284</b>	0.2004
04-Nov-07	1.38531	<b>1.38809</b>	0.2004
05-Nov-07	1.60419	<b>1.60740</b>	0.2004
06-Nov-07	1.5275	<b>1.53056</b>	0.2004
07-Nov-07	1.4359	<b>1.43878</b>	0.2004
08-Nov-07	1.3834	<b>1.38617</b>	0.2004
09-Nov-07	1.3429	<b>1.34559</b>	0.2004
10-Nov-07	1.1804	<b>1.18277</b>	0.2004
11-Nov-07	1.2973	<b>1.29990</b>	0.2004
12-Nov-07	1.5881	<b>1.59128</b>	0.2004
13-Nov-07	1.4491	<b>1.45200</b>	0.2004
14-Nov-07	1.3859	<b>1.38868</b>	0.2004
15-Nov-07	1.4705	<b>1.47345</b>	0.2004
16-Nov-07	1.5312	<b>1.53427</b>	0.2004
17-Nov-07	1.3744	<b>1.37715</b>	0.2004
18-Nov-07	1.4082	<b>1.41102</b>	0.2004
19-Nov-07	1.4919	<b>1.49489</b>	0.2004

20-Nov-07	1.3143	<b>1.31693</b>	0.2004
21-Nov-07	1.1353	<b>1.13758</b>	0.2004
22-Nov-07	1.1027	<b>1.10491</b>	0.2004
23-Nov-07	1.2278	<b>1.23026</b>	0.2004
24-Nov-07	1.1865	<b>1.18888</b>	0.2004
25-Nov-07	1.0496	<b>1.05170</b>	0.2004
26-Nov-07	1.192	<b>1.19439</b>	0.2004
27-Nov-07	1.118	<b>1.12024</b>	0.2004
28-Nov-07	1.0971	<b>1.09930</b>	0.2004
29-Nov-07	1.1442	<b>1.14649</b>	0.2004
30-Nov-07	1.1892	<b>1.19158</b>	0.2004
01-Dec-07	1.2722	<b>1.27475</b>	0.2004
02-Dec-07	1.3768	<b>1.37956</b>	0.2004
03-Dec-07	1.1549	<b>1.15721</b>	0.2004
04-Dec-07	1.0451	<b>1.04719</b>	0.2004
05-Dec-07	0.943	<b>0.94489</b>	0.2004
06-Dec-07	1.2096	<b>1.21202</b>	0.2004
07-Dec-07	1.2021	<b>1.20451</b>	0.2004
08-Dec-07	1.22	<b>1.22244</b>	0.2004
09-Dec-07	1.1311	<b>1.13337</b>	0.2004
10-Dec-07	1.2802	<b>1.28277</b>	0.2004
11-Dec-07	1.2676	<b>1.27014</b>	0.2004
12-Dec-07	1.3555	<b>1.35822</b>	0.2004
13-Dec-07	1.3354	<b>1.33808</b>	0.2004
14-Dec-07	1.4689	<b>1.47184</b>	0.2004
15-Dec-07	1.3138	<b>1.31643</b>	0.2004
16-Dec-07	1.4002	<b>1.40301</b>	0.2004
17-Dec-07	1.4121	<b>1.41493</b>	0.2004
18-Dec-07	1.3121	<b>1.31473</b>	0.2004
19-Dec-07	1.4346	<b>1.43747</b>	0.2004
20-Dec-07	1.5965	<b>1.59970</b>	0.2004
21-Dec-07	1.4829	<b>1.48587</b>	0.2004
22-Dec-07	1.3477	<b>1.35040</b>	0.2004
23-Dec-07	1.2922	<b>1.29479</b>	0.2004
24-Dec-07	1.3722	<b>1.37495</b>	0.2004
25-Dec-07	1.2422	<b>1.24469</b>	0.2004
26-Dec-07	1.2274	<b>1.22986</b>	0.2004
27-Dec-07	0.9956	<b>0.99760</b>	0.2004
28-Dec-07	0.8994	<b>0.90120</b>	0.2004
29-Dec-07	1.0917	<b>1.09389</b>	0.2004
30-Dec-07	1.0445	<b>1.04659</b>	0.2004
31-Dec-07	1.0186	<b>1.02064</b>	0.2004
01-Jan-08	1.0243	<b>1.02635</b>	0.2004
02-Jan-08	1.2148	<b>1.21723</b>	0.2004
03-Jan-08	1.3732	<b>1.37595</b>	0.2004
04-Jan-08	1.2756	<b>1.27816</b>	0.2004
05-Jan-08	1.126	<b>1.12826</b>	0.2004
06-Jan-08	1.1861	<b>1.18848</b>	0.2004
07-Jan-08	1.29539	<b>1.29799</b>	0.2004
08-Jan-08	1.1789	<b>1.18126</b>	0.2004
09-Jan-08	1.1857	<b>1.18808</b>	0.2004
10-Jan-08	1.1657	<b>1.16804</b>	0.2004
11-Jan-08	1.2499	<b>1.25240</b>	0.2004
12-Jan-08	1.1601	<b>1.16242</b>	0.2004
13-Jan-08	1.1328	<b>1.13507</b>	0.2004
14-Jan-08	1.1264	<b>1.12866</b>	0.2004
15-Jan-08	1.1032	<b>1.10541</b>	0.2004
16-Jan-08	1.1244	<b>1.12665</b>	0.2004
17-Jan-08	1.2272	<b>1.22966</b>	0.2004

18-Jan-08	1.0988	<b>1.10100</b>	0.2004
19-Jan-08	1.0045	<b>1.00651</b>	0.2004
20-Jan-08	0.8603	<b>0.86202</b>	0.2004
21-Jan-08	1.0588	<b>1.06092</b>	0.2004
22-Jan-08	1.2047	<b>1.20711</b>	0.2004
23-Jan-08	1.0086	<b>1.01062</b>	0.2004
24-Jan-08	1.1128	<b>1.11503</b>	0.2004
25-Jan-08	0.93481	<b>0.93668</b>	0.2004
26-Jan-08	0.98219	<b>0.98416</b>	0.2004
27-Jan-08	0.9949	<b>0.99689</b>	0.2004
28-Jan-08	1.0048	<b>1.00681</b>	0.2004
29-Jan-08	1.0612	<b>1.06333</b>	0.2004
30-Jan-08	1.1056	<b>1.10782</b>	0.2004
31-Jan-08	1.2313	<b>1.23377</b>	0.2004
01-Feb-08	1.2843	<b>1.28687</b>	0.2004
02-Feb-08	1.1981	<b>1.20050</b>	0.2004
03-Feb-08	1.1892	<b>1.19158</b>	0.2004
04-Feb-08	1.1765	<b>1.17886</b>	0.2004
05-Feb-08	1.136	<b>1.13828</b>	0.2004
06-Feb-08	1.0877	<b>1.08988</b>	0.2004
07-Feb-08	1.0665	<b>1.06864</b>	0.2004
08-Feb-08	0.9851	<b>0.98707</b>	0.2004
09-Feb-08	0.8388	<b>0.84048</b>	0.2004
10-Feb-08	1.018	<b>1.02004</b>	0.2004
11-Feb-08	1.174	<b>1.17635</b>	0.2004
12-Feb-08	1.0789	<b>1.08106</b>	0.2004
13-Feb-08	1.0914	<b>1.09359</b>	0.2004
14-Feb-08	1.1959	<b>1.19830</b>	0.2004
15-Feb-08	1.1989	<b>1.20130</b>	0.2004
16-Feb-08	1.3952	<b>1.39800</b>	0.2004
17-Feb-08	1.6149	<b>1.61814</b>	0.2004
18-Feb-08	1.581	<b>1.58417</b>	0.2004
19-Feb-08	1.3203	<b>1.32295</b>	0.2004
20-Feb-08	1.4659	<b>1.46884</b>	0.2004
21-Feb-08	1.1076	<b>1.10982</b>	0.2004
22-Feb-08	1.0769	<b>1.07906</b>	0.2004
23-Feb-08	0.9285	<b>0.93036</b>	0.2004
24-Feb-08	0.9866	<b>0.98858</b>	0.2004
25-Feb-08	1.155	<b>1.15731</b>	0.2004
26-Feb-08	0.9833	<b>0.98527</b>	0.2004
27-Feb-08	1.042	<b>1.04409</b>	0.2004
28-Feb-08	1.0252	<b>1.02725</b>	0.2004
29-Feb-08	1.0675	<b>1.06964</b>	0.2004
01-Mar-08	0.9722	<b>0.97415</b>	0.2004
02-Mar-08	0.935	<b>0.93687</b>	0.2004
03-Mar-08	1.1502	<b>1.15251</b>	0.2004
04-Mar-08	1.1193	<b>1.12154</b>	0.2004
05-Mar-08	1.1634	<b>1.16573</b>	0.2004
06-Mar-08	1.0047	<b>1.00671</b>	0.2004
07-Mar-08	0.9532	<b>0.95511</b>	0.2004
08-Mar-08	0.9469	<b>0.94880</b>	0.2004
09-Mar-08	0.9702	<b>0.97214</b>	0.2004
10-Mar-08	1.0141	<b>1.01613</b>	0.2004
11-Mar-08	1.0737	<b>1.07585</b>	0.2004
12-Mar-08	1.1418	<b>1.14409</b>	0.2004
13-Mar-08	1.0381	<b>1.04018</b>	0.2004
14-Mar-08	0.9738	<b>0.97575</b>	0.2004
15-Mar-08	0.9052	<b>0.90701</b>	0.2004
16-Mar-08	1.0238	<b>1.02585</b>	0.2004

17-Mar-08	1.049	<b>1.05110</b>	0.2004
18-Mar-08	1.0844	<b>1.08657</b>	0.2004
19-Mar-08	1.0305	<b>1.03257</b>	0.2004
20-Mar-08	1.0747	<b>1.07685</b>	0.2004
21-Mar-08	1.0706	<b>1.07275</b>	0.2004
22-Mar-08	1.0993	<b>1.10150</b>	0.2004
23-Mar-08	1.0146	<b>1.01663</b>	0.2004
24-Mar-08	1.1103	<b>1.11253</b>	0.2004
25-Mar-08	1.2257	<b>1.22816</b>	0.2004
26-Mar-08	1.1909	<b>1.19329</b>	0.2004
27-Mar-08	1.0281	<b>1.03016</b>	0.2004
28-Mar-08	1.0235	<b>1.02555</b>	0.2004
29-Mar-08	1.0004	<b>1.00240</b>	0.2004
30-Mar-08	0.9093	<b>0.91112</b>	0.2004
31-Mar-08	0.9275	<b>0.92936</b>	0.2004
01-Apr-08	1.0341	<b>1.03617</b>	0.2004
02-Apr-08	0.9055	<b>0.90731</b>	0.2004
03-Apr-08	0.8324	<b>0.83407</b>	0.2004
04-Apr-08	0.8502	<b>0.85190</b>	0.2004
05-Apr-08	0.94131	<b>0.94320</b>	0.2004
06-Apr-08	1.08759	<b>1.08977</b>	0.2004
07-Apr-08	1.05251	<b>1.05462</b>	0.2004
08-Apr-08	1.02209	<b>1.02414</b>	0.2004
09-Apr-08	1.0361	<b>1.03818</b>	0.2004
10-Apr-08	1	<b>1.00200</b>	0.2004
11-Apr-08	1.0053	<b>1.00731</b>	0.2004
12-Apr-08	0.9483	<b>0.95020</b>	0.2004
13-Apr-08	0.9436	<b>0.94549</b>	0.2004
14-Apr-08	0.9281	<b>0.92996</b>	0.2004
15-Apr-08	0.9864	<b>0.98838</b>	0.2004
16-Apr-08	0.9862	<b>0.98818</b>	0.2004
17-Apr-08	0.9784	<b>0.98036</b>	0.2004
18-Apr-08	1.0493	<b>1.05140</b>	0.2004
19-Apr-08	0.956	<b>0.95792</b>	0.2004
20-Apr-08	0.9384	<b>0.94028</b>	0.2004
21-Apr-08	0.8532	<b>0.85491</b>	0.2004
22-Apr-08	0.74339	<b>0.74488</b>	0.2004
23-Apr-08	1.3048	<b>1.30741</b>	0.2004
24-Apr-08	1.3883	<b>1.39108</b>	0.2004
25-Apr-08	1.49471	<b>1.49771</b>	0.2004
26-Apr-08	1.2871	<b>1.28968</b>	0.2004
27-Apr-08	1.38419	<b>1.38696</b>	0.2004
28-Apr-08	1.58981	<b>1.59300</b>	0.2004
29-Apr-08	1.4772	<b>1.48016</b>	0.2004
30-Apr-08	1.522	<b>1.52505</b>	0.2004
01-May-08	1.4763	<b>1.47926</b>	0.2004
02-May-08	1.3264	<b>1.32906</b>	0.2004
03-May-08	1.1507	<b>1.15301</b>	0.2004
04-May-08	1.1464	<b>1.14870</b>	0.2004
05-May-08	1.1487	<b>1.15100</b>	0.2004
06-May-08	1.01	<b>1.01202</b>	0.2004
07-May-08	0.9138	<b>0.91563</b>	0.2004
08-May-08	0.8542	<b>0.85591</b>	0.2004
09-May-08	0.8331	<b>0.83477</b>	0.2004
10-May-08	0.8064	<b>0.80802</b>	0.2004
11-May-08	0.7899	<b>0.79148</b>	0.2004
12-May-08	0.8604	<b>0.86212</b>	0.2004
13-May-08	0.8483	<b>0.85000</b>	0.2004
14-May-08	0.856	<b>0.85772</b>	0.2004

15-May-08	0.8947	<b>0.89649</b>	0.2004
16-May-08	0.952	<b>0.95391</b>	0.2004
17-May-08	1.1179	<b>1.12014</b>	0.2004
18-May-08	1.0563	<b>1.05842</b>	0.2004
19-May-08	1.0964	<b>1.09860</b>	0.2004
20-May-08	1.1016	<b>1.10381</b>	0.2004
21-May-08	1.0224	<b>1.02445</b>	0.2004
22-May-08	0.9141	<b>0.91593</b>	0.2004
23-May-08	0.9079	<b>0.90972</b>	0.2004
24-May-08	0.8297	<b>0.83136</b>	0.2004
25-May-08	1.002	<b>1.00401</b>	0.2004
26-May-08	0.9675	<b>0.96944</b>	0.2004
27-May-08	1.1742	<b>1.17655</b>	0.2004
28-May-08	1.1413	<b>1.14359</b>	0.2004
29-May-08	0.8952	<b>0.89699</b>	0.2004
30-May-08	0.8255	<b>0.82715</b>	0.2004
31-May-08	0.7443	<b>0.74579</b>	0.2004
01-Jun-08	0.8576	<b>0.85932</b>	0.2004
02-Jun-08	0.8347	<b>0.83637</b>	0.2004
03-Jun-08	0.8948	<b>0.89659</b>	0.2004
04-Jun-08	0.8313	<b>0.83297</b>	0.2004
05-Jun-08	0.8465	<b>0.84820</b>	0.2004
06-Jun-08	0.8162	<b>0.81784</b>	0.2004
07-Jun-08	0.8248	<b>0.82645</b>	0.2004
08-Jun-08	0.7737	<b>0.77525</b>	0.2004
09-Jun-08	0.768	<b>0.76954</b>	0.2004
10-Jun-08	0.7777	<b>0.77926</b>	0.2004
11-Jun-08	0.8166	<b>0.81824</b>	0.2004
12-Jun-08	0.8831	<b>0.88487</b>	0.2004
13-Jun-08	0.9476	<b>0.94950</b>	0.2004
14-Jun-08	0.8216	<b>0.82325</b>	0.2004
15-Jun-08	0.9175	<b>0.91934</b>	0.2004
16-Jun-08	0.9027	<b>0.90451</b>	0.2004
17-Jun-08	0.9984	<b>1.00040</b>	0.2004
18-Jun-08	1.0009	<b>1.00291</b>	0.2004
19-Jun-08	0.9119	<b>0.91373</b>	0.2004
20-Jun-08	0.8511	<b>0.85281</b>	0.2004
21-Jun-08	0.9698	<b>0.97174</b>	0.2004
22-Jun-08	0.9995	<b>1.00150</b>	0.2004
23-Jun-08	0.8811	<b>0.88287</b>	0.2004
24-Jun-08	0.8872	<b>0.88898</b>	0.2004
25-Jun-08	0.8466	<b>0.84830</b>	0.2004
26-Jun-08	0.9839	<b>0.98587</b>	0.2004
27-Jun-08	0.934	<b>0.93587</b>	0.2004
28-Jun-08	0.7907	<b>0.79228</b>	0.2004
29-Jun-08	0.8272	<b>0.82886</b>	0.2004
30-Jun-08	0.8211	<b>0.82275</b>	0.2004
01-Jul-08	0.7714	<b>0.77295</b>	0.2004
02-Jul-08	0.846	<b>0.84770</b>	0.2004
03-Jul-08	0.8518	<b>0.85351</b>	0.2004
04-Jul-08	0.7776	<b>0.77916</b>	0.2004
05-Jul-08	0.75	<b>0.75150</b>	0.2004
06-Jul-08	0.7612	<b>0.76273</b>	0.2004
07-Jul-08	0.8432	<b>0.84489</b>	0.2004
08-Jul-08	0.8797	<b>0.88146</b>	0.2004
09-Jul-08	0.9368	<b>0.93868</b>	0.2004
10-Jul-08	0.8235	<b>0.82515</b>	0.2004
11-Jul-08	0.8454	<b>0.84709</b>	0.2004
12-Jul-08	0.8118	<b>0.81343</b>	0.2004

13-Jul-08	0.7013	<b>0.70271</b>	0.2004
14-Jul-08	0.7567	<b>0.75822</b>	0.2004
15-Jul-08	0.7639	<b>0.76543</b>	0.2004
16-Jul-08	0.808	<b>0.80962</b>	0.2004
17-Jul-08	0.8635	<b>0.86523</b>	0.2004
18-Jul-08	0.81989	<b>0.82153</b>	0.2004
19-Jul-08	0.76501	<b>0.76654</b>	0.2004
20-Jul-08	0.7803	<b>0.78186</b>	0.2004
21-Jul-08	0.8597	<b>0.86142</b>	0.2004
22-Jul-08	0.78249	<b>0.78406</b>	0.2004
23-Jul-08	0.7093	<b>0.71072</b>	0.2004
24-Jul-08	0.7726	<b>0.77415</b>	0.2004
25-Jul-08	0.6977	<b>0.69910</b>	0.2004
26-Jul-08	0.6529	<b>0.65421</b>	0.2004
27-Jul-08	0.4256	<b>0.42645</b>	0.2004
28-Jul-08	0.232	<b>0.23246</b>	0.2004
29-Jul-08	0.7169	<b>0.71834</b>	0.2004
30-Jul-08	0.03751	<b>0.03759</b>	0.2004
31-Jul-08	0	<b>0.00000</b>	0.0000
01-Aug-08	0	<b>0.00000</b>	0.0000
02-Aug-08	0	<b>0.00000</b>	0.0000
03-Aug-08	0	<b>0.00000</b>	0.0000
04-Aug-08	0.3229	<b>0.32355</b>	0.2004
05-Aug-08	0	<b>0.00000</b>	0.0000
06-Aug-08	0	<b>0.00000</b>	0.0000
07-Aug-08	0	<b>0.00000</b>	0.0000
08-Aug-08	0	<b>0.00000</b>	0.0000
09-Aug-08	0	<b>0.00000</b>	0.0000
10-Aug-08	0	<b>0.00000</b>	0.0000
11-Aug-08	0	<b>0.00000</b>	0.0000
12-Aug-08	0	<b>0.00000</b>	0.0000
13-Aug-08	0	<b>0.00000</b>	0.0000
14-Aug-08	0	<b>0.00000</b>	0.0000
15-Aug-08	0	<b>0.00000</b>	0.0000
16-Aug-08	0	<b>0.00000</b>	0.0000
17-Aug-08	0	<b>0.00000</b>	0.0000
18-Aug-08	0	<b>0.00000</b>	0.0000
19-Aug-08	0.0311	<b>0.03116</b>	0.2004
20-Aug-08	0	<b>0.00000</b>	0.0000
21-Aug-08	0	<b>0.00000</b>	0.0000
22-Aug-08	0.0106	<b>0.01062</b>	0.2004
23-Aug-08	0.0017	<b>0.00170</b>	0.2004
24-Aug-08	0.0051	<b>0.00511</b>	0.2004
25-Aug-08	0	<b>0.00000</b>	0.0000
26-Aug-08	0.0267	<b>0.02675</b>	0.2004
27-Aug-08	0.02049	<b>0.02050</b>	0.0569