



ASSESSMENT OF ERROR DUE TO ORIFICE DIAMETER MIS-MEASUREMENT AT PETERS GREEN

A Report for

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

PROJECT NO: NGR010

REPORT NO: 2010/285

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

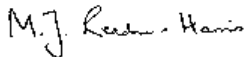
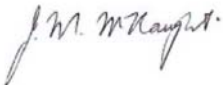
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A Report for

**National Grid
Brick Kiln Street
HINCKLEY
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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 Peters Green correction factors should be applied as follows:

Meter tube	Date	Correction factor <i>$q_{m,c}/q_{m,o}$</i>
MTA	13/06/2007 to 07/07/2008	1.002053
MTB	13/06/2007 to 10/07/2008	1.002094

Over the period 13/06/2007 to 10/07/2008 inclusive the flow and corrected flow in the two tubes were as follows:

	MTA	MTB
Flow (mscm)	638.62148	1553.35961
Corrected flow (mscm)	639.93257	1556.60589

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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 Peters Green in the period of the error. The Joint Office Error Codes are NT004 and NT005 for meter tubes MTA and MTB.

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	Values at 20 °C
					Orifice bore (mm)
OP50099	697-2	18/08/2005	326.7505	21	326.7453
OP50100	696-2	18/08/2005	326.604	21	326.5988
OP5050	697-1	09/03/2005	326.9765	21	326.9713
OP5056	696-1	09/03/2005	326.6215	21	326.6163
OP60034	697-2	13/03/2006	326.751	21	326.7458
OP60036	696-2	14/03/2006	326.6055	21	326.6003
OP70042	696-1	17/04/2007	326.327	21	326.3218
OP70043	697-1	17/04/2007	326.6805	21	326.6753
OP70067	696-2	20/06/2007	326.294	21	326.2888
OP70068	697-2	20/06/2007	326.451	21	326.4458
OP80036	696-1	09/07/2008	326.6305	20	326.6305
OP80043	697-1	04/08/2008	326.987	20	326.9870
OP90042	697-1	28/10/2009	326.987	20.2	326.9860
OP90045	696-1	04/11/2009	326.621	20.5	326.6184

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 plates were mis-measured.

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

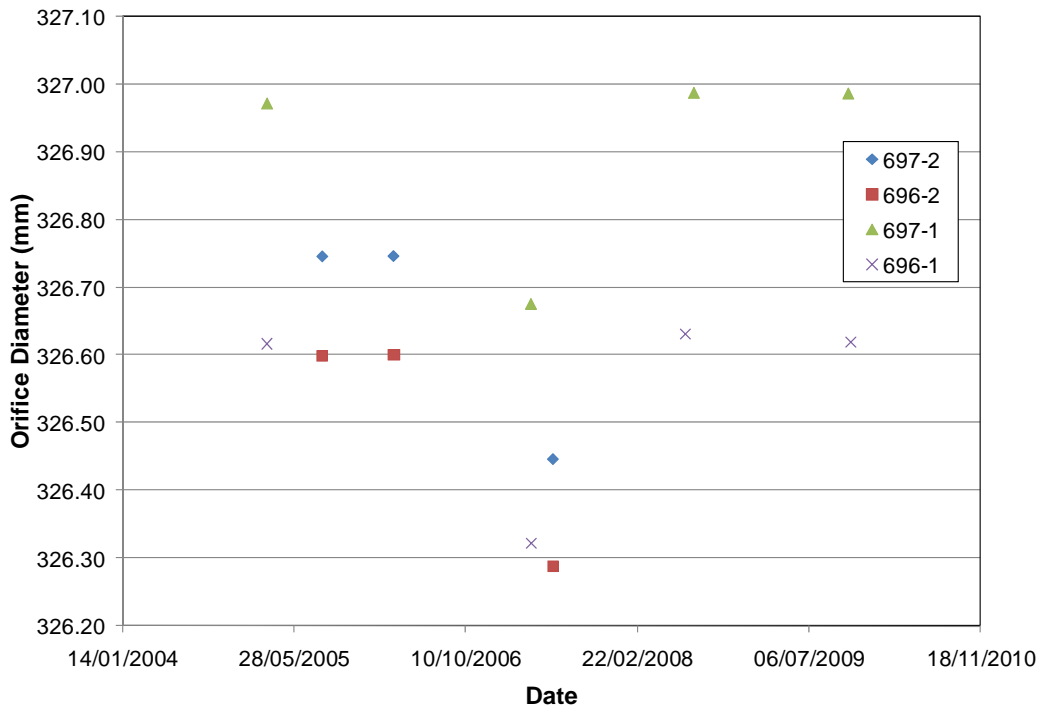


Figure 1 Orifice Diameters at 20 °C

The plates actually used in each of the two meter tubes are given in Table 2.

TABLE 2

PLATES USED IN EACH LINE AS CONFIGURED BY FLOW COMPUTER –PART 1

Configuration data	omnM0418.cfg	omnM0613.cfg	omnN0331.cfg
MTA	18/04/2007 23:01	13/06/2007 23:01	31/03/2008 23:01
Orifice plate bore diameter (mm)	326.6055	326.327	326.327
Expansion coefficient of the plate (/°C)	0.000016	0.000016	0.000016
Orifice plate calibration temperature	21	21	21
Meter tube diameter (mm)	580.3932	580.3932	580.3932
Expansion coefficient of the meter tube (/°C)	0.000011	0.000011	0.000011
Meter tube calibration temperature	20	20	20
Isentropic Exponent	1.3418	1.3418	1.343617
Dynamic Viscosity (Pa.s)	0.0000119	0.0000119	0.0000119
Orifice plate certificate number	OP60036	OP70042	OP70042
Orifice plate serial number	696-2	696-1	696-1
Error in orifice diameter?	No	Yes	Yes
MTB			
Orifice plate bore diameter (mm)	326.751	326.6805	326.6805
Expansion coefficient of the plate (/°C)	0.000016	0.000016	0.000016
Orifice plate calibration temperature	21	21	21
Meter tube diameter (mm)	580.6884	580.6884	580.6884
Expansion coefficient of the meter tube (/°C)	0.000011	0.000011	0.000011
Meter tube calibration temperature	20	20	20
Isentropic Exponent	1.3418	1.3418	1.343617
Dynamic Viscosity (Pa.s)	0.0000119	0.0000119	0.0000119
Orifice plate certificate number	OP60034	OP70043	OP70043
Orifice plate serial number	697-2	697-1	697-1
Error in orifice diameter?	No	Yes	Yes

PLATES USED IN EACH LINE AS CONFIGURED BY FLOW COMPUTER – PART 2

Configuration data	omnN0710.cfg	omnN0828.cfg	omnN1003.cfg
MTA	10/07/2008 23:01	28/08/2008 23:01	03/10/2008 23:01
Orifice plate bore diameter (mm)	326.327	326.327	326.987
Expansion coefficient of the plate (1/°C)	0.000016	0.000016	0.000016
Orifice plate calibration temperature	21	21	20
Meter tube diameter (mm)	580.3932	580.3932	580.3932
Expansion coefficient of the meter tube (1/°C)	0.000011	0.000011	0.000011
Meter tube calibration temperature	20	20	20
Isentropic Exponent	1.343617	1.343617	1.343617
Dynamic Viscosity (Pa.s)	0.0000119	0.0000119	0.0000119
Orifice plate certificate number	OP70042	OP70042	OP80043
Orifice plate serial number	696-1	696-1	697-1
Error in orifice diameter?	Yes	Yes	No
MTB			
Orifice plate bore diameter (mm)	326.6305	326.6305	326.6305
Expansion coefficient of the plate (1/°C)	0.000016	0.000016	0.000016
Orifice plate calibration temperature	21	20	20
Meter tube diameter (mm)	580.6884	580.6884	580.6884
Expansion coefficient of the meter tube (1/°C)	0.000011	0.000011	0.000011
Meter tube calibration temperature	20	20	20
Isentropic Exponent	1.343617	1.343617	1.343617
Dynamic Viscosity (Pa.s)	0.0000119	0.0000119	0.0000119
Orifice plate certificate number	OP70043	OP80036	OP80036
Orifice plate serial number	697-1	696-1	696-1
Error in orifice diameter?	Yes	No	No

There is a column missing from the flow computer logs supplied. This problem came to light because on 28/08/2008 at 23:01 the same plate (with different calibrations) appears to be in both tubes. Plate 696-1 was in fact removed from MTA on 07/07/2008. There was no plate in MTA till 03/10/2008: so the configurations for MTA for 10/07/2008 and 28/08/2008 are wrong (but do not cause error). In MTB on 10/07/2008 it was clear that either the orifice diameter was wrong or both the orifice plate certificate number and the calibration temperature were wrong. In fact the latter were wrong (from the data supplied the plate could have been changed on 10/07/2008, but not on 28/08/2008). The correction due to the diameter mis-measurement alone has been calculated; the error in the flow due to the error in the calibration temperature in MTB from 10/07/2008 to 28/08/2008 has been ignored.

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 eight-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:

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

The correct orifice 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 56 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 13/06/2007 to 31/03/2008 the correction on MTA can be calculated as in Table 3. Throughout this calculation the meter tube diameter is 580.3932 mm, the isentropic exponent is 1.3418 and the dynamic viscosity is 0.0000119 Pa s.

TABLE 3

THE CORRECTION ON MTA FROM 13/06/2007 TO 31/03/2008

	d mm	β	ε	Re_D	C	$\frac{q_{m,c}}{q_{m,o}}$
Original: $\Delta p=10$ mbar	326.3218	0.562243	0.999941	3071832	0.603845	
Corrected $\Delta p=10$ mbar	326.6217	0.562759	0.999941	3078140	0.603851	1.0020535
Original $\Delta p=500$ mbar	326.3218	0.562243	0.997039	21649929	0.603617	
Corrected $\Delta p=500$ mbar	326.6217	0.562759	0.997038	21694361	0.603623	1.0020523

So $q_{m,c}/q_{m,o}$ is 1.002053.

Over the period from 13/06/2007 to 31/03/2008 the correction on MTB can be calculated as in Table 4. Throughout this calculation the meter tube diameter is 580.6884 mm, the isentropic exponent is 1.3418 and the dynamic viscosity is 0.0000119 Pa s.

TABLE 4

THE CORRECTION ON MTB FROM 13/06/2007 TO 31/03/2008

	d mm	β	ε	Re_D	C	$\frac{q_{m,c}}{q_{m,o}}$
Original: $\Delta p=10$ mbar	326.6753	0.562566	0.999941	3077336	0.603848	
Corrected $\Delta p=10$ mbar	326.9814	0.563093	0.999941	3083780	0.603854	1.0020941
Original $\Delta p=500$ mbar	326.6753	0.562566	0.997039	21688707	0.603621	
Corrected $\Delta p=500$ mbar	326.9814	0.563093	0.997038	21734100	0.603626	1.0020929

So $q_{m,c}/q_{m,o}$ is 1.002094.

Over the period from 31/03/2008 to 07/07/2008 the correction on MTA can be calculated as in Table 5. Throughout this calculation the meter tube diameter is 580.3932 mm, the isentropic exponent is 1.343617 and the dynamic viscosity is 0.0000119 Pa s.

TABLE 5
THE CORRECTION ON MTA FROM 31/03/2008 TO 07/07/2008

	d mm	β	ε	Re_D	C	$\frac{q_{m,c}}{q_{m,o}}$
Original: $\Delta p=10$ mbar	326.3218	0.562243	0.999941	3071832	0.603845	
Corrected $\Delta p=10$ mbar	326.6217	0.562759	0.999941	3078140	0.603851	1.0020535
Original $\Delta p=500$ mbar	326.3218	0.562243	0.997043	21650015	0.603617	
Corrected $\Delta p=500$ mbar	326.6217	0.562759	0.997042	21694448	0.603623	1.0020523

So $q_{m,c}/q_{m,o}$ is 1.002053.

Over the period from 31/03/2008 to 10/07/2008 the correction on MTB can be calculated as in Table 6. Throughout this calculation the meter tube diameter is 580.6884 mm, the isentropic exponent is 1.343617 and the dynamic viscosity is 0.0000119 Pa s.

TABLE 6
THE CORRECTION ON MTB FROM 31/03/2008 TO 10/07/2008

	d mm	β	ε	Re_D	C	$\frac{q_{m,c}}{q_{m,o}}$
Original: $\Delta p=10$ mbar	326.6753	0.562566	0.999941	3077336	0.603848	
Corrected $\Delta p=10$ mbar	326.9814	0.563093	0.999941	3083781	0.603854	1.0020941
Original $\Delta p=500$ mbar	326.6753	0.562566	0.997043	21688794	0.603621	
Corrected $\Delta p=500$ mbar	326.9814	0.563093	0.997042	21734187	0.603626	1.0020929

So $q_{m,c}/q_{m,o}$ is 1.002094.

4 CORRECTIONS ON A DAILY BASIS

Each (approximately eight-minute) interval was considered and the flow (here and throughout this paragraph flow refers to standard volume flow) was calculated in each tube; the flowrate during the interval was taken as the average of that at the beginning and that at the end of the interval. The interval is only known to the nearest minute; so the flow in MTA during the interval was calculated by taking the product of the total flow (supplied by National Grid) during that interval and the ratio of the calculated flow in MTA to the sum of the calculated flows in the tubes. Intervals in which the calculated flow in both MTA and MTB is zero have been disregarded. Then on taking account of the effects at the beginning and end of each day the sum of the daily flow in MTA (obtained by summing the flows in each interval) and that in MTB (obtained the same way) should be equal to the total flow in that

day. To ensure that the sum of the daily flows is exactly equal to the total daily flow the individual totals were scaled. Then the increase in daily flow was calculated for each of the two daily flows by using the percentage increase for each tube given above. Finally the total increase in the daily flow is the sum of the increases for the two tubes. The results are given in Table B.1 of Appendix B. The sum of the flows and the sum of the corrections have also been calculated by meter tube. It was assumed that on 13/06/2007 the orifice plates in MTA and MTB were changed at 10:00 and 14:00 respectively, that on 07/07/2008 the orifice plate in MTA was changed at 11:00, and that on 10/07/2008 the orifice plate in MTB was changed at 11:00.

5 CONCLUSIONS

Correction factors should be applied as shown in Table 7.

TABLE 7
CORRECTION FACTORS

Meter tube	Date	Correction factor $q_{m,c}/q_{m,o}$
MTA	13/06/2007 to 07/07/2008	1.002053
MTB	13/06/2007 to 10/07/2008	1.002094

These correction factors apply to both measured volume and measured energy.

On applying these corrections the corrected volumes are as shown in Appendix B.

Flows by meter tube are as shown in Table 8.

TABLE 8
FLOW IN THE PERIOD 13/06/2007 TO 10/07/2008 INCLUSIVE

	MTA	MTB
Flow (mscm)	638.62148	1553.35961
Correction (mscm)	1.31109	3.24628
Corrected flow (mscm)	639.93257	1556.60589
% change	0.2053	0.2090

**APPENDIX A
ORIFICE PLATE CALIBRATION CERTIFICATES**

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 18-08-05
REF NO: OP50099
TEMPERATURE: 21 degsC

MEASURED ORIFICE BORE: 326.7505mm

PLATE DETAILS

PLATE SERIAL. 697-2	PLATE O.D 647.720mm		
MANUFACTURER:	PIPE I.D: 580.694mm	SITE: PETERS GREEN	
MATERIAL CERT.No.	DESIGN BORE: 326.587mm	FLOW: 10.8X10E06 M ³ /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 %	0.159	0.181	0.174	0.166	0.189	0.206	0.197	0.158
'E' mm	11.476	11.465	11.373	11.333	11.327	11.355	11.406	11.457
	8.502	8.496	8.443	8.415	8.401	8.439	8.451	8.477
EDGE SHARPNESS mm	0.025	0.025	0.025	0.0125	0.025	0.025	0.0375	0.025
BEVEL ANGLE	37 DEGS							
CONCENTRICITY	0.036mm							
SURFACE FINISH (Ra)	4.7 microns							
DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS								
ROUNDNESS	0.012mm	TAPER:		0 degs				

COMMENTS:

INSPECTED BY



P. KENNERSON

TRANSCO ORIFICE PLATE CALIBRATION

DATE: 09-03-05
REF NO: OP5050
TEMPERATURE: 21 degsC

MEASURED ORIFICE BORE: 326.9765mm

PLATE DETAILS

PLATE SERIAL. 697-1 PLATE O.D 647.653mm
 MANUFACTURER: PIPE I.D: 580.745mm SITE: PETERS GREEN
 MATERIAL CERT.No. DESIGN BORE: 326.600mm FLOW: 10800000 M³/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
FLATNESS μ	0.106	0.135	0.096	0.117	0.137	0.104	0.119
VE mm	12.228	12.088	12.128	12.149	12.221	12.352	12.303
le mm	9.586	9.586	9.579	9.591	9.644	9.736	9.792
EDGE SHARPNESS mm	0.0125	0.0125	0.0125	0.0250	0.0125	0.0250	0.0125
BEVEL ANGLE:	37 DEGS						
CONCENTRICITY	0.207mm						
SURFACE FINISH (Ra)	2.5 microns						
DOWNSTREAM FACE/EDGE VISUAL INSPECTION	PASS						
ROUNDNESS :	0.012mm	TAPER:		0 degs			

COMMENTS:

INSPECTED BY.  G. WARDLE
 VERIFIED BY..  P. KENNERSON

TRANSCO ORIFICE PLATE CALIBRATION

DATE: 09-03-05
REF NO: OP5056
TEMPERATURE: 21 degsC
MEASURED ORIFICE BORE: 326.6215mm

PLATE DETAILS

PLATE SERIAL. 696-1 PLATE O.D 647.728mm
 MANUFACTURER: PIPE I.D: 580.517mm SITE: PETERS GREEN
 MATERIAL CERT.No. DESIGN BORE 326.587mm FLOW: 10800000 M³/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 μ	0.114	0.112	0.120	0.096	0.123	0.119	0.098	0.13
E' mm	11.612	11.683	11.750	11.716	11.640	11.676	11.674	11.632
mm	8.175	8.229	8.308	8.344	8.311	8.231	8.206	8.215
EDGE SHARPNESS mm	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
BEVEL ANGLE:	36 DEGS							
CONCENTRICITY	0.034mm							
SURFACE FINISH (Ra)	5.1 microns							
DOWNSTREAM FACE/EDGE VISUAL INSPECTION	PASS							
ROUNDNESS :	0.022mm	TAPER: 0 degs						

COMMENTS:

INSPECTED BY:  G. WARDLE
 VERIFIED BY:  P. KENNERSON

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 13-03-06
 REF NO: OP60034
 TEMPERATURE: 21 degsC

MEASURED ORIFICE BORE: 326.751mm

PLATE DETAILS

PLATE SERIAL. 697-2 PLATE O.D 647.744mm
 MANUFACTURER: PIPE I.D: 580.694mm SITE: PETERS GREEN
 MATERIAL CERT.No. DESIGN BORE: 326.587mm FLOW: 10.8*10E06 M³/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:- 14/10/06

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS:-	1	2	3	4	5	6	7	8
FLATNESS %	0.165	0.207	0.179	0.169	0.184	0.225	0.182	0.174
E' mm	11.472	11.462	11.385	11.328	11.337	11.368	11.410	11.456
e' mm	8.504	8.512	8.451	8.401	8.417	8.438	8.448	8.519
EDGE SHARPNESS mm	0.0125	0.0125	0.0125	SQUARE	0.0125	0.0125	0.0125	0.0125
BEVEL ANGLE:	37 DEGS							
CONCENTRICITY	0.024mm							
SURFACE FINISH (Ra)	3.9 microns							

DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS

ROUNDNESS : 0.009mm TAPER: 0 degs

COMMENTS

INSPECTED BY:  P. KENNERSON

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 14-03-06
 REF NO: OP60036
 TEMPERATURE: 21 degsC
 MEASURED ORIFICE BORE: 326.6055mm

PLATE DETAILS

PLATE SERIAL: 696-2 PLATE O.D: 647.625mm
 MANUFACTURER: PIPE I.D: 580.745mm SITE: PETERS GREEN
 MATERIAL CERT.No: DESIGN BORE: 326.600mm FLOW: 10.8*10E06 M³/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:- 14/10/06

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS:-	1	2	3	4	5	6	7	8
FLATNESS %	0.082	0.095	0.115	0.085	0.058	0.070	0.088	0.082
'E' mm	11.594	11.593	11.627	11.603	11.603	11.642	11.676	11.611
'e' mm	9.111	9.159	9.168	9.168	9.142	9.145	9.147	9.115
EDGE SHARPNESS mm	0.020	0.0125	SQUARE	0.05	0.0125	0.0125	SQUARE	SQUARE
BEVEL ANGLE:	37 DEGS							
CONCENTRICITY	0.035mm							
SURFACE FINISH (Ra)	6.2 microns							
DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS								
ROUNDNESS	0.016mm	TAPER:		0 degs				

COMMENTS:

INSPECTED BY:



P. KENNERSON

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 17-04-07
REF NO: OP70042
TEMPERATURE: 21 degsC

MEASURED ORIFICE BORE: 326.327mm

PLATE DETAILS

PLATE SERIAL: 696-1 PLATE O.D: 647.741mm
 MANUFACTURER: PIPE I.D: 580.517mm SITE: PETERS GREEN
 MATERIAL CERT.No: DESIGN BORE: 326.587mm FLOW: 10.8X10E06 M³/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:	1	2	3	4	5	6	7	8
FLATNESS %	0.104	0.126	0.105	0.116	0.133	0.104	0.136	0.123
'E' mm	11.658	11.662	11.736	11.747	11.680	11.664	11.660	11.678
EDGE SHARPNESS mm	8.219	8.214	8.310	8.386	8.349	8.238	8.204	8.246
BEVEL ANGLE:	35 DEGS							
CONCENTRICITY	1.059mm							
SURFACE FINISH (Ra)	5.1 microns							
DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS								
ROUNDNESS	0.279mm	TAPER: 0 degs						

COMMENTS

INSPECTED BY:  P. KENNERSON

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 17-04-07
REF NO: OP70043
TEMPERATURE: 21 degsC
MEASURED ORIFICE BORE: 326.6805mm

PLATE DETAILS

PLATE SERIAL. 697-1 PLATE O.D 647.119mm
 MANUFACTURER: PIPE I.D: 580.745mm SITE: PETERS GREEN
 MATERIAL CERT.No. DESIGN BORE: 326.600mm FLOW: 10.8X10E06 M³/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:	1	2	3	4	5	6	7	8
FLATNESS μ	0.130	0.139	0.099	0.127	0.135	0.106	0.125	0.100
'E' mm	12.216	12.084	12.117	12.192	12.256	12.311	12.301	12.294
mm	9.636	9.570	9.582	9.632	9.684	9.723	9.763	9.789
EDGE SHARPNESS mm	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125
BEVEL ANGLE:	37 DEGS							
CONCENTRICITY	0.168mm							
SURFACE FINISH (Ra)	2.3 microns							

DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS

ROUNDNESS 0.310mm TAPER: 0 degs

COMMENTS

INSPECTED BY:  P. KENNERSON

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 20-06-07
REF NO: OP70067
TEMPERATURE: 21 degsC

MEASURED ORIFICE BORE: 326.294mm

PLATE DETAILS

PLATE SERIAL. 696-2 PLATE O.D. 647.100mm
 MANUFACTURER: PIPE I.D.: mm SITE: PETERS GREEN
 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, UKAS TRACEABLE CERT:- 7325. NEXT CAL DUE:- 02-OCTOBER-2010

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS:	1	2	3	4	5	6	7	8
FLATNESS μ	0.082	0.104	0.110	0.061	0.060	0.075	0.083	0.069
BE mm	11.643	11.571	11.598	11.664	11.662	11.617	11.645	11.658
EDGE SHARPNESS mm	9.152	9.128	9.149	9.206	9.183	9.115	9.117	9.147
BEVEL ANGLE	37 DEGS							
CONCENTRICITY	0.067mm							
SURFACE FINISH (Ra)	1.2 microns							
DOWNSTREAM FACE/EDGE VISUAL INSPECTION	PASS							
ROUNDNESS	0.292mm	TAPER:	0 degs					

DRAINHOLE PRESENT ? (YES/NO): No

COMMENTS:

INSPECTED BY: J Chauhan.

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 20-06-07
REF NO: OP70068
TEMPERATURE: 21 degsC

MEASURED ORIFICE BORE: 326.451mm

PLATE DETAILS

PLATE SERIAL. 697-2 PLATE O.D 647.178mm
 MANUFACTURER: PIPE I.D: mm SITE PETERS GREEN
 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 μ	0.170	0.190	0.178	0.064	0.193	0.201	0.163	0.176
'E' mm	11.536	11.453	11.455	11.394	11.385	11.443	11.410	11.504
'e' mm	8.559	8.499	8.433	8.450	8.451	8.410	8.463	8.533
EDGE SHARPNESS mm	0.025	0.0375	0.025	0.025	0.025	0.0125	0.0125	0.025
BEVEL ANGLE	37 DEGS							
CONCENTRICITY	28.711mm							
SURFACE FINISH (Ra)	3.1 microns							
DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS								
ROUNDNESS :	0.280mm	TAPER:		0 degs				

COMMENTS:

INSPECTED BY

 J. CHMUKHAN

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 9-JULY-2008
REF NO: OP80036
TEMPERATURE: 20 degsC
MEASURED ORIFICE BORE: 326.6305mm

PLATE DETAILS

PLATE SERIAL: 696-1 PLATE O.D: 647.722mm
 MANUFACTURER: PIPE I.D: 580.3932mm SITE: PETERS GREEN 1
 MATERIAL CERT.No. DESIGN BORE: 326.587mm FLOW: 10.8X10E06 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
PLATNESS %	0.114	0.131	0.106	0.121	0.133	0.100	0.120	0.125
'E' mm	11.598	11.665	11.747	11.701	11.627	11.675	11.676	11.610
'e' mm	8.196	8.221	8.301	8.349	8.310	8.251	8.222	8.204
EDGE SHARPNESS mm	0.025	0.0125	0.0125	0.0125	0.025	0.025	0.025	0.0125
BEVEL ANGLE	37 DEGS							
CONCENTRICITY	0.039mm							
SURFACE FINISH (Ra)	2.5 microns							
DOWNSTREAM FACE/EDGE VISUAL INSPECTION	PASS							
ROUNDNESS :	0.021mm	TAPER: 0 degs						

DRAINHOLE PRESENT ? (YES/NO): No

COMMENTS: LIGHT BLACK GREASE ON U-STREAM

INSPECTED BY:  M Livingstone

COLLIN'S

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 04-AUG-2008

REF NO: OP80043

TEMPERATURE: 20 degsC

MEASURED ORIFICE BORE: 326.987mm

PLATE DETAILS

PLATE SERIAL.	697-1	PLATE O.D	647.637mm	SITE:	PETERS GREEN 1
MANUFACTURER:		PIPE I.D:	580.884mm	DESIGN BORE:	mm
MATERIAL CERT.No				FLOW:	10.8X10E06 M ³ /DAY

TEST EQUIPMENT

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

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS	1	2	3	4	5	6	7	8
FLATNESS μ	0.126	0.144	0.126	0.131	0.148	0.111	0.129	0.126
	12.141	12.088	12.116	12.118	12.100	12.128	12.130	12.119
	9.593	9.575	9.614	9.606	9.627	9.732	9.767	9.716
EDGE SHARPNESS mm	SQUARE	SQUARE	SQUARE	SQUARE	0.0125	SQUARE	0.0125	SQUARE
BEVEL ANGLE:	37 DEGS							
CONCENTRICITY	0.202mm							
SURFACE FINISH (Ra)	1.9 microns							
DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS								
ROUNDNESS	0.009mm	TAPER	0 degs					

DRAINHOLE PRESENT ? (YES/NO): No

COMMENTS: LIGHT BLACK GREASE U-STREAM FACE

INSPECTED BY:  M Livingstone

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 28-OCT-2009

REF NO: OP90042

TEMPERATURE: 20.2 degsC

MEASURED ORIFICE BORE: 326.987mm

PLATE DETAILS

PLATE SERIAL.	697-1	PLATE O.D	647.635mm		
MANUFACTURER:		PIPE I.D:	580.3932mm	SITE:	PETERS GREEN 1 MTA
MATERIAL CERT.No.		DESIGN BORE:	mm	FLOW:	10.8X10E06 M ³ /DAY

TEST EQUIPMENT

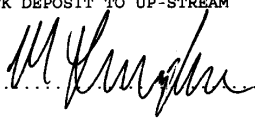
MANUFACTURER & TYPE: KEMCO 700 MANUAL 3-DIMENSIONAL MEASURING MACHINE ASSET NO OP-A02
 CALIBRATED BY: QUALITY CONTROL TECHNOLOGY, UKAS TRACEABLE CERT:- 7325. NEXT CAL DUE:- 02-OCTOBER-2010

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS	1	2	3	4	5	6	7	8
FLATNESS %	0.114	0.137	0.120	0.126	0.147	0.113	0.125	0.119
	12.142	12.105	12.114	12.116	12.120	12.108	12.132	12.121
	9.593	9.571	9.607	9.575	9.643	9.697	9.755	9.743
EDGE SHARPNESS mm	0.0125	0.0125	SQUARE	SQUARE	SQUARE	SQUARE	0.0125	0.025
BEVEL ANGLE	37 DEGS							
CONCENTRICITY	0.197mm							
SURFACE FINISH (Ra)	1.2 microns							
DOWNSTREAM FACE/EDGE VISUAL INSPECTION	PASS							
ROUNDNESS 0.010mm	TAPER: 0 degs							

DRAINHOLE PRESENT ? (YES/NO) No

COMMENTS: BLACK DEPOSIT TO UP-STREAM

INSPECTED BY:  M Livingstone

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 04-NOV-2009
 REF NO: OP90045
 TEMPERATURE: 20.5 degsC
 MEASURED ORIFICE BORE: 326.621mm

PLATE DETAILS

PLATE SERIAL: 696-1
 MANUFACTURER:
 MATERIAL CERT.No
 PLATE O.D 647.719mm
 PIPE I.D: 580.6884mm
 DESIGN BORE: 326.587mm
 SITE: PETERS GREEN 1 MTP
 FLOW: 10.8 X 10E06 M^3/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	3	4	5	6	8
FLATNESS %	0.106	0.132	0.112	0.119	0.135	0.128	0.128
'E' mm	11.627	11.677	11.742	11.694	11.635	11.683	11.680
'e' mm	8.202	8.220	8.290	8.348	8.312	8.241	8.223
EDGE SHARPNESS mm	0.025	0.0125	0.0125	0.0125	0.025	0.025	0.025
BEVEL ANGLE:	37 DEGS						
CONCENTRICITY	0.063mm						
SURFACE FINISH (Ra)	2.47 microns						

DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS

ROUNDNESS : 0.018mm TAPER 0 degs

DRAINHOLE PRESENT ? (YES/NO) No

COMMENTS: LIGHT GREASE NO UPSTREAM

INSPECTED BY:  M Livingstone

APPENDIX B CORRECTED DAILY VOLUME FLOWS

TABLE B.1

FLOWS AT PETERS GREEN DURING THE PERIOD OF THE MIS-MEASUREMENT

	Original Values (total)	Corrected values (total)	% increase
Date	Volume (mscm)	Volume (mscm)	Volume (mscm)
13/6/2007	2.795	2.79910	0.1465
14/6/2007	2.6728	2.67840	0.2094
15/6/2007	2.8665	2.87250	0.2094
16/6/2007	2.7539	2.75967	0.2094
17/6/2007	2.7603	2.76608	0.2094
18/6/2007	2.9865	2.99275	0.2094
19/6/2007	2.6538	2.65936	0.2094
20/6/2007	2.6627	2.66828	0.2094
21/6/2007	2.663	2.66858	0.2094
22/6/2007	2.6538	2.65936	0.2094
23/6/2007	2.6853	2.69092	0.2094
24/6/2007	2.933	2.93914	0.2094
25/6/2007	3.1736	3.18025	0.2094
26/6/2007	3.2594	3.26623	0.2094
27/6/2007	3.4628	3.47005	0.2094
28/6/2007	3.2048	3.21151	0.2094
29/6/2007	2.9805	2.98674	0.2094
30/6/2007	3.033	3.03935	0.2094
1/7/2007	2.7494	2.75516	0.2094
2/7/2007	2.949	2.95518	0.2094
3/7/2007	3.0272	3.03354	0.2094
4/7/2007	3.2811	3.28797	0.2094
5/7/2007	3.7287	3.73650	0.2091
6/7/2007	3.6191	3.62668	0.2094
7/7/2007	2.9079	2.91399	0.2094
8/7/2007	2.871	2.87701	0.2094
9/7/2007	2.9565	2.96269	0.2094
10/7/2007	2.8728	2.87882	0.2094
11/7/2007	2.822	2.82791	0.2094
12/7/2007	2.915	2.92110	0.2094
13/7/2007	2.8583	2.86429	0.2094
14/7/2007	2.6014	2.60685	0.2094
15/7/2007	2.6971	2.70275	0.2094
16/7/2007	2.5316	2.53690	0.2094
17/7/2007	2.0627	2.06702	0.2094
18/7/2007	2.7242	2.72990	0.2094
19/7/2007	2.4314	2.43649	0.2094
20/7/2007	2.9704	2.97662	0.2094
21/7/2007	2.9823	2.98854	0.2094
22/7/2007	2.8415	2.84745	0.2094
23/7/2007	3.0155	3.02181	0.2094
24/7/2007	2.8166	2.82250	0.2094
25/7/2007	2.8652	2.87120	0.2094
26/7/2007	3.0747	3.08114	0.2094
27/7/2007	3.0552	3.06160	0.2094

28/7/2007	2.6584	2.66397	0.2094
29/7/2007	2.8305	2.83643	0.2094
30/7/2007	3.0061	3.01239	0.2094
31/7/2007	2.8542	2.86018	0.2094
1/8/2007	2.7739	2.77971	0.2094
2/8/2007	2.8041	2.80997	0.2094
3/8/2007	2.7278	2.73351	0.2094
4/8/2007	2.3614	2.36634	0.2094
5/8/2007	2.3961	2.40112	0.2094
6/8/2007	2.6166	2.62208	0.2094
7/8/2007	2.609	2.61446	0.2094
8/8/2007	2.6073	2.61276	0.2094
9/8/2007	2.7262	2.73191	0.2094
10/8/2007	2.6475	2.65304	0.2094
11/8/2007	2.3641	2.36905	0.2094
12/8/2007	2.8118	2.81769	0.2094
13/8/2007	2.7024	2.70806	0.2094
14/8/2007	2.9106	2.91669	0.2094
15/8/2007	2.8669	2.87290	0.2094
16/8/2007	2.8926	2.89866	0.2094
17/8/2007	2.726	2.73171	0.2094
18/8/2007	2.7617	2.76748	0.2094
19/8/2007	2.9135	2.91960	0.2094
20/8/2007	3.434	3.44119	0.2094
21/8/2007	3.5592	3.56665	0.2094
22/8/2007	3.7173	3.72508	0.2094
23/8/2007	3.5687	3.57617	0.2094
24/8/2007	3.2512	3.25801	0.2094
25/8/2007	2.7902	2.79604	0.2094
26/8/2007	2.5443	2.54963	0.2094
27/8/2007	2.759	2.76478	0.2094
28/8/2007	2.90089	2.90696	0.2094
29/8/2007	2.89771	2.90378	0.2094
30/8/2007	2.9356	2.94175	0.2094
31/8/2007	2.9442	2.95037	0.2094
1/9/2007	2.7879	2.79374	0.2094
2/9/2007	2.8298	2.83573	0.2094
3/9/2007	3.0216	3.02793	0.2094
4/9/2007	3.5409	3.54831	0.2094
5/9/2007	2.9907	2.99696	0.2094
6/9/2007	2.3714	2.37637	0.2094
7/9/2007	2.2208	2.22545	0.2094
8/9/2007	2.6708	2.67639	0.2094
9/9/2007	2.5386	2.54392	0.2094
10/9/2007	2.6642	2.66978	0.2094
11/9/2007	2.7245	2.73021	0.2094
12/9/2007	2.6764	2.68200	0.2094
13/9/2007	2.5755	2.58089	0.2094
14/9/2007	2.6875	2.69313	0.2094
15/9/2007	2.8343	2.84024	0.2094
16/9/2007	2.8338	2.83973	0.2094
17/9/2007	3.4592	3.46644	0.2094
18/9/2007	3.1767	3.18335	0.2094
19/9/2007	4.183	4.19176	0.2094
20/9/2007	3.801	3.80896	0.2094
21/9/2007	3.1422	3.14878	0.2094
22/9/2007	3.2054	3.21211	0.2094

23/9/2007	3.16	3.16662	0.2094
24/9/2007	3.3784	3.38547	0.2094
25/9/2007	4.1247	4.13334	0.2094
26/9/2007	4.9159	4.92619	0.2094
27/9/2007	5.3188	5.32993	0.2092
28/9/2007	5.0458	5.05637	0.2094
29/9/2007	4.3617	4.37083	0.2094
30/9/2007	4.4598	4.46914	0.2094
1/10/2007	4.9435	4.95385	0.2094
2/10/2007	4.7166	4.72648	0.2094
3/10/2007	4.4362	4.44549	0.2094
4/10/2007	4.2274	4.23625	0.2094
5/10/2007	4.1594	4.16810	0.2091
6/10/2007	4.2585	4.26742	0.2094
7/10/2007	4.3369	4.34598	0.2094
8/10/2007	4.7147	4.72457	0.2094
9/10/2007	5.0247	5.03522	0.2094
10/10/2007	4.9426	4.95295	0.2094
11/10/2007	4.7063	4.71615	0.2094
12/10/2007	4.0489	4.05738	0.2094
13/10/2007	3.3636	3.37064	0.2094
14/10/2007	3.5761	3.58359	0.2094
15/10/2007	3.7944	3.80235	0.2094
16/10/2007	4.2909	4.29989	0.2094
17/10/2007	4.7903	4.80033	0.2094
18/10/2007	5.7895	5.80161	0.2091
19/10/2007	6.367	6.38030	0.2089
20/10/2007	5.5705	5.58216	0.2094
21/10/2007	5.6549	5.66674	0.2094
22/10/2007	6.4273	6.44072	0.2088
23/10/2007	6.8107	6.82483	0.2075
24/10/2007	7.0665	7.08116	0.2074
25/10/2007	6.79471	6.80880	0.2074
26/10/2007	6.5508	6.56439	0.2074
27/10/2007	6.1567	6.16950	0.2079
28/10/2007	5.5393	5.55090	0.2094
29/10/2007	6.4905	6.50404	0.2087
30/10/2007	6.6242	6.63800	0.2084
31/10/2007	6.4544	6.46782	0.2079
1/11/2007	5.7162	5.72813	0.2086
2/11/2007	5.3224	5.33353	0.2090
3/11/2007	5.2318	5.24276	0.2094
4/11/2007	6.2314	6.24445	0.2094
5/11/2007	7.1959	7.21088	0.2081
6/11/2007	7.2186	7.23362	0.2081
7/11/2007	6.6694	6.68333	0.2089
8/11/2007	6.7019	6.71592	0.2091
9/11/2007	7.4086	7.42400	0.2079
10/11/2007	6.3483	6.36148	0.2077
11/11/2007	6.6851	6.69898	0.2077
12/11/2007	8.6388	8.65672	0.2074
13/11/2007	8.5166	8.53426	0.2074
14/11/2007	8.4858	8.50342	0.2076
15/11/2007	9.2931	9.31238	0.2074
16/11/2007	9.8289	9.84929	0.2074
17/11/2007	9.0837	9.10255	0.2075
18/11/2007	8.9925	9.01117	0.2076

19/11/2007	8.2551	8.27225	0.2078
20/11/2007	7.995	8.01161	0.2078
21/11/2007	7.1723	7.18721	0.2078
22/11/2007	7.368	7.38331	0.2078
23/11/2007	8.9476	8.96616	0.2074
24/11/2007	9.4028	9.42230	0.2074
25/11/2007	7.9651	7.98163	0.2076
26/11/2007	8.0564	8.07311	0.2074
27/11/2007	7.4817	7.49725	0.2078
28/11/2007	7.1006	7.11536	0.2078
29/11/2007	7.4391	7.45455	0.2077
30/11/2007	6.8249	6.83911	0.2081
1/12/2007	7.3637	7.37904	0.2083
2/12/2007	7.5345	7.55014	0.2075
3/12/2007	7.9143	7.93072	0.2075
4/12/2007	7.5168	7.53241	0.2076
5/12/2007	6.7789	6.79302	0.2084
6/12/2007	6.8576	6.87187	0.2080
7/12/2007	7.7451	7.76117	0.2075
8/12/2007	8.2938	8.31100	0.2074
9/12/2007	8.3626	8.37998	0.2078
10/12/2007	9.3123	9.33162	0.2074
11/12/2007	9.9758	9.99649	0.2074
12/12/2007	10.5068	10.52859	0.2074
13/12/2007	10.6668	10.68892	0.2074
14/12/2007	10.0516	10.07245	0.2074
15/12/2007	10.2729	10.29422	0.2075
16/12/2007	10.2592	10.28048	0.2074
17/12/2007	10.6765	10.69864	0.2074
18/12/2007	10.3237	10.34513	0.2076
19/12/2007	10.4774	10.49913	0.2074
20/12/2007	11.0466	11.06951	0.2074
21/12/2007	10.6433	10.66537	0.2074
22/12/2007	9.5886	9.60849	0.2074
23/12/2007	9.8784	9.89889	0.2074
24/12/2007	7.75069	7.76680	0.2078
25/12/2007	6.8142	6.82836	0.2077
26/12/2007	8.1406	8.15751	0.2077
27/12/2007	7.2144	7.22939	0.2078
28/12/2007	7.7857	7.80185	0.2074
29/12/2007	8.072	8.08874	0.2074
30/12/2007	8	8.01662	0.2078
31/12/2007	8.1896	8.20660	0.2076
1/1/2008	7.9866	8.00319	0.2077
2/1/2008	9.8146	9.83496	0.2074
3/1/2008	10.8646	10.88713	0.2074
4/1/2008	9.2065	9.22561	0.2075
5/1/2008	9.0244	9.04312	0.2074
6/1/2008	9.2064	9.22549	0.2074
7/1/2008	9.5587	9.57852	0.2074
8/1/2008	9.2508	9.26999	0.2074
9/1/2008	9.1892	9.20828	0.2076
10/1/2008	8.5044	8.52205	0.2075
11/1/2008	8.7003	8.71836	0.2075
12/1/2008	9.0149	9.03361	0.2076
13/1/2008	8.0159	8.03255	0.2077
14/1/2008	8.5259	8.54358	0.2074

15/1/2008	7.9941	8.01069	0.2075
16/1/2008	9.1209	9.13982	0.2074
17/1/2008	9.1778	9.19688	0.2079
18/1/2008	7.8277	7.84397	0.2078
19/1/2008	6.263	6.27608	0.2089
20/1/2008	6.4099	6.42327	0.2086
21/1/2008	7.5429	7.55857	0.2078
22/1/2008	8.3252	8.34250	0.2078
23/1/2008	7.2809	7.29602	0.2077
24/1/2008	7.4807	7.49624	0.2077
25/1/2008	8.1283	8.14519	0.2078
26/1/2008	7.582	7.59776	0.2079
27/1/2008	7.4584	7.47391	0.2080
28/1/2008	8.2944	8.31163	0.2078
29/1/2008	7.8559	7.87221	0.2076
30/1/2008	8.5637	8.58147	0.2075
31/1/2008	9.345	9.36441	0.2078
1/2/2008	9.8148	9.83516	0.2074
2/2/2008	9.7708	9.79106	0.2074
3/2/2008	9.1388	9.15776	0.2075
4/2/2008	8.7939	8.81215	0.2076
5/2/2008	8.2055	8.22254	0.2076
6/2/2008	8.6568	8.67475	0.2074
7/2/2008	8.3308	8.34810	0.2076
8/2/2008	7.9694	7.98596	0.2077
9/2/2008	7.7541	7.77020	0.2077
10/2/2008	7.97421	7.99075	0.2074
11/2/2008	8.4902	8.50783	0.2076
12/2/2008	8.568	8.58580	0.2077
13/2/2008	8.5834	8.60120	0.2074
14/2/2008	9.6916	9.71171	0.2075
15/2/2008	9.7566	9.77684	0.2074
16/2/2008	9.9892	10.00992	0.2074
17/2/2008	9.6964	9.71651	0.2074
18/2/2008	9.78249	9.80278	0.2074
19/2/2008	9.4096	9.42912	0.2074
20/2/2008	9.93031	9.95091	0.2074
21/2/2008	8.5788	8.59659	0.2074
22/2/2008	7.5654	7.58110	0.2075
23/2/2008	7.306	7.32117	0.2076
24/2/2008	7.1044	7.11915	0.2076
25/2/2008	8.2448	8.26190	0.2074
26/2/2008	7.675	7.69092	0.2075
27/2/2008	7.8569	7.87321	0.2076
28/2/2008	7.3378	7.35305	0.2078
29/2/2008	7.1691	7.18399	0.2077
1/3/2008	5.7604	5.77239	0.2082
2/3/2008	5.4419	5.45325	0.2086
3/3/2008	7.5825	7.59829	0.2082
4/3/2008	9.2903	9.30957	0.2074
5/3/2008	8.8075	8.82578	0.2076
6/3/2008	8.15	8.16691	0.2075
7/3/2008	7.7316	7.74767	0.2078
8/3/2008	7.8048	7.82102	0.2078
9/3/2008	7.9454	7.96191	0.2078
10/3/2008	9.1054	9.12428	0.2074
11/3/2008	8.3171	8.33436	0.2076

12/3/2008	8.9559	8.97447	0.2074
13/3/2008	8.3543	8.37166	0.2078
14/3/2008	7.239	7.25404	0.2077
15/3/2008	6.491	6.50450	0.2080
16/3/2008	8.058	8.07475	0.2078
17/3/2008	8.7527	8.77085	0.2074
18/3/2008	9.1231	9.14203	0.2075
19/3/2008	9.0233	9.04203	0.2076
20/3/2008	8.7925	8.81075	0.2076
21/3/2008	8.4752	8.49278	0.2074
22/3/2008	9.4549	9.47451	0.2074
23/3/2008	9.9841	10.00481	0.2074
24/3/2008	10.0592	10.08008	0.2076
25/3/2008	9.6297	9.64971	0.2078
26/3/2008	8.264	8.28116	0.2076
27/3/2008	7.8184	7.83463	0.2076
28/3/2008	8.2209	8.23796	0.2075
29/3/2008	7.5537	7.56938	0.2076
30/3/2008	6.5615	6.57513	0.2077
31/3/2008	7.1484	7.16325	0.2077
1/4/2008	6.6731	6.68698	0.2080
2/4/2008	6.2713	6.28434	0.2080
3/4/2008	5.7853	5.79736	0.2084
4/4/2008	5.767	5.77900	0.2081
5/4/2008	7.0026	7.01719	0.2083
6/4/2008	9.0049	9.02358	0.2074
7/4/2008	8.9943	9.01295	0.2074
8/4/2008	8.1494	8.16632	0.2076
9/4/2008	7.4169	7.43233	0.2080
10/4/2008	7.1582	7.17311	0.2082
11/4/2008	7.10819	7.12296	0.2078
12/4/2008	6.80051	6.81464	0.2077
13/4/2008	7.037	7.05162	0.2078
14/4/2008	7.2292	7.24422	0.2078
15/4/2008	6.9115	6.92587	0.2079
16/4/2008	6.9564	6.97086	0.2078
17/4/2008	7.6639	7.67981	0.2076
18/4/2008	7.6213	7.63713	0.2078
19/4/2008	8.2047	8.22173	0.2076
20/4/2008	6.9073	6.92165	0.2077
21/4/2008	6.4771	6.49057	0.2079
22/4/2008	5.97449	5.98693	0.2083
23/4/2008	5.882	5.89425	0.2083
24/4/2008	5.6147	5.62640	0.2084
25/4/2008	4.87659	4.88677	0.2088
26/4/2008	4.11691	4.12552	0.2091
27/4/2008	4.6229	4.63258	0.2094
28/4/2008	4.871	4.88116	0.2085
29/4/2008	6.0374	6.04998	0.2084
30/4/2008	6.7976	6.81174	0.2080
1/5/2008	6.2579	6.27094	0.2083
2/5/2008	5.5626	5.57423	0.2091
3/5/2008	4.3111	4.32009	0.2086
4/5/2008	3.6935	3.70123	0.2094
5/5/2008	3.1947	3.20139	0.2094
6/5/2008	3.5634	3.57086	0.2094
7/5/2008	2.8884	2.89445	0.2094

8/5/2008	2.667	2.67258	0.2094
9/5/2008	2.8093	2.81518	0.2094
10/5/2008	2.7194	2.72509	0.2094
11/5/2008	2.8773	2.88333	0.2094
12/5/2008	2.8785	2.88453	0.2094
13/5/2008	2.8734	2.87942	0.2094
14/5/2008	2.8752	2.88122	0.2094
15/5/2008	3.64589	3.65352	0.2094
16/5/2008	4.8187	4.82879	0.2094
17/5/2008	5.0274	5.03793	0.2094
18/5/2008	4.3541	4.36322	0.2094
19/5/2008	4.9193	4.92957	0.2087
20/5/2008	4.8997	4.90994	0.2090
21/5/2008	4.0681	4.07660	0.2090
22/5/2008	2.9558	2.96199	0.2094
23/5/2008	3.2819	3.28877	0.2094
24/5/2008	3.0109	3.01720	0.2094
25/5/2008	3.439	3.44620	0.2094
26/5/2008	4.3608	4.36993	0.2094
27/5/2008	3.801	3.80894	0.2090
28/5/2008	3.6041	3.61165	0.2094
29/5/2008	3.7491	3.75695	0.2094
30/5/2008	3.1714	3.17804	0.2094
31/5/2008	2.8123	2.81819	0.2094
1/6/2008	2.8526	2.85857	0.2094
2/6/2008	3.2216	3.22835	0.2094
3/6/2008	3.4573	3.46454	0.2094
4/6/2008	3.4792	3.48649	0.2094
5/6/2008	3.1833	3.18997	0.2094
6/6/2008	3.007	3.01330	0.2094
7/6/2008	2.8396	2.84555	0.2094
8/6/2008	2.7411	2.74684	0.2094
9/6/2008	2.733	2.73872	0.2094
10/6/2008	2.5404	2.54572	0.2094
11/6/2008	3.0156	3.02191	0.2094
12/6/2008	3.0717	3.07813	0.2094
13/6/2008	3.172	3.17864	0.2094
14/6/2008	2.8521	2.85807	0.2094
15/6/2008	2.805	2.81087	0.2094
16/6/2008	2.8258	2.83172	0.2094
17/6/2008	3.0942	3.10068	0.2094
18/6/2008	3.3219	3.32886	0.2094
19/6/2008	2.9725	2.97872	0.2094
20/6/2008	2.9695	2.97572	0.2094
21/6/2008	3.2207	3.22744	0.2094
22/6/2008	2.9814	2.98764	0.2094
23/6/2008	3.0596	3.06601	0.2094
24/6/2008	2.8545	2.86048	0.2094
25/6/2008	2.7501	2.75586	0.2094
26/6/2008	2.5498	2.55514	0.2094
27/6/2008	3.0009	3.00718	0.2094
28/6/2008	2.8285	2.83442	0.2094
29/6/2008	2.8174	2.82330	0.2094
30/6/2008	3.1011	3.10759	0.2094
1/7/2008	2.7772	2.78302	0.2094
2/7/2008	2.7734	2.77921	0.2094
3/7/2008	2.9068	2.91289	0.2094

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4/7/2008	2.4907	2.49592	0.2094
5/7/2008	2.8786	2.88463	0.2094
6/7/2008	3.0446	3.05098	0.2094
7/7/2008	2.8912	2.89725	0.2094
8/7/2008	3.0782	3.08465	0.2094
9/7/2008	3.1226	3.12914	0.2094
10/7/2008	2.8969	2.89825	0.0466