



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

A Report for

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

PROJECT NO: NGR010

REPORT NO: 2010/250

DATE: 17 JUNE 2010



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

## **NOTES**

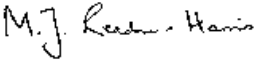
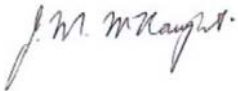
- 1** This report may be published in full by the client unless it includes information supplied in confidence by TUV NEL Ltd or any third party. Such information, if included within the report, shall be identified as confidential by TUV NEL Ltd.
- 2a** The prior written consent of TUV NEL Ltd shall be obtained by the client before publication by them of any extract from, or abridgement of, this report.
- 2b** The prior written consent of TUV NEL Ltd shall be obtained by the client before publication:
- Where such publication is made in connection with any public enquiry, legal proceedings or arbitration.
  - Where such publication is made in connection with any company prospectus or similar document.
  - Where the client has notice that TUV NEL Ltd is seeking or intends to seek patent or like protection for any intellectual property produced in the course of rendering the services.

TUV NEL Ltd  
East Kilbride  
GLASGOW G75 0QF  
UK  
Tel: +44 (0)1355 220222  
Fax: +44 (0)1355 272999  
[www.tuvnel.com](http://www.tuvnel.com)

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

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: 17 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 Luxborough Lane correction factors should be applied as follows:

<b>Meter tube</b>	<b>Date</b>	<b>Correction factor</b> <i><math>q_{m,c}/q_{m,o}</math></i>
MTA	19/06/2007 to 13/05/2008	1.002142
MTB	19/06/2007 to 13/05/2008	1.002103

Over the period 29/08/2007 to 01/10/2008 inclusive the flow and corrected flow in the two tubes were as follows:

	<b>MTA</b>	<b>MTB</b>
Flow (mscm)	762.38050	29.01457
Corrected flow (mscm)	764.01341	29.07559

**CONTENTS**

	<b>Page No</b>
EXECUTIVE SUMMARY .....	2
1 INTRODUCTION .....	4
2 ORIFICE DIAMETERS .....	4
3 CORRECTING THE FLOWRATE .....	6
4 CORRECTIONS ON A DAILY BASIS .....	9
5 CONCLUSIONS .....	10
APPENDIX A ORIFICE PLATE CALIBRATION CERTIFICATES .....	11
APPENDIX B CORRECTED DAILY VOLUME FLOWS .....	24

## 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 Luxborough Lane in the period of the error. The Joint Office Error Codes are NT002 and NT003 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)
OP5107	Lux-2-1	16/05/2005	329.856	21*	329.8507
OP5108	549-2	16/05/2005	329.9805	21	329.9752
OP60091	549-2	12/06/2006	329.986	20	329.9860
OP60101	Lux-1-1	23/11/2006	329.856	21	329.8507
OP60133	548-1	23/11/2006	329.9965	20	329.9965
OP70017	549-2	08/06/2007	329.676	21	329.6707
OP70018	Lux-2-1	08/06/2007	329.559	21	329.5537
OP80015	Lux-1-1	12/05/2008	329.8695	20	329.8695
OP80016	548-1	12/05/2008	330.002	20	330.0020
OP80037	549-2	11/07/2008	329.996	20	329.9960
OP80039	Lux-2-1	14/07/2008	329.875	20	329.8750
OP90015	Lux-1-1	21/05/2009	329.8635	20.5	329.8609
OP90016	548-1	28/05/2009	329.997	20.6	329.9938

\* Temperature not specified on certificate, presumed the same as 5108.

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 the plates were mis-measured.

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

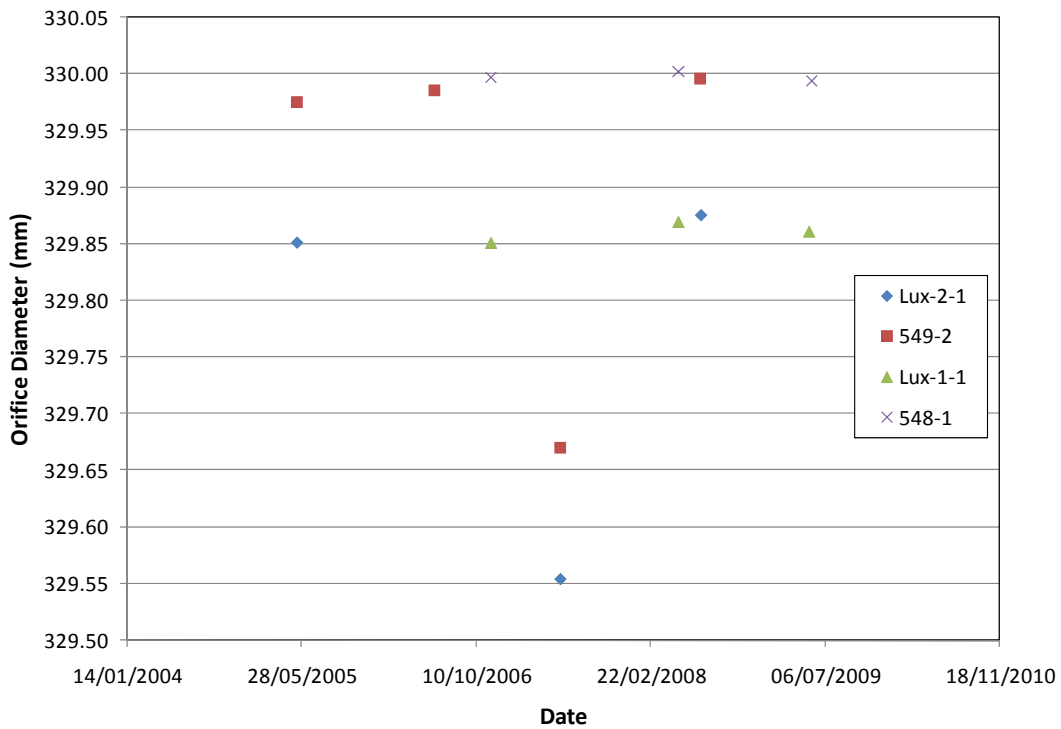


Figure 1 Orifice Diameters at 20 °C

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

TABLE 2

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

Configuration data	omnL1129.cfg	omnM0619.cfg	omnM0628.cfg	omnM0703.cfg
MTA	30/11/2006 00:01	19/06/2007 23:01	28/06/2007 23:01	03/07/2007 23:01
Orifice plate bore diameter (mm)	329.856	329.676	329.676	329.676
Expansion coefficient of the plate (/°C)	0.000016	0.000016	0.000016	0.000016
Orifice plate calibration temperature	21	21	21	21
Meter tube diameter (mm)	581.1605	581.1605	581.1605	581.1605
Expansion coefficient of the meter tube (/°C)	0.000011	0.000011	0.000011	0.000011
Meter tube calibration temperature	20	20	20	20
Isentropic Exponent	1.3375	1.3375	1.3375	1.3375
Dynamic Viscosity (Pa.s)	0.0000119	0.0000119	0.0000119	0.0000119
Orifice plate certificate number	OP60101	OP70017	OP70017	OP70017
Orifice plate serial number	Lux-1-1	549-2	549-2	549-2
Error in orifice diameter?	No	Yes	Yes	Yes
MTB				
Orifice plate bore diameter (mm)	329.9965	329.559	329.559	329.559
Expansion coefficient of the plate (/°C)	0.000016	0.000016	0.000016	0.000016
Orifice plate calibration temperature	20	20	21	20
Meter tube diameter (mm)	580.4789	580.4789	580.4789	580.4789
Expansion coefficient of the meter tube (/°C)	0.000011	0.000011	0.000011	0
Meter tube calibration temperature	20	20	20	20
Isentropic Exponent	1.3375	1.3375	1.3375	1.3375
Dynamic Viscosity (Pa.s)	0.0000119	0.0000119	0.0000119	0.0000119
Orifice plate certificate number	OP60133	OP70018	OP70018	OP70018
Orifice plate serial number	548-1	Lux-2-1	Lux-2-1	Lux-2-1
Error in orifice diameter?	No	Yes	Yes	Yes

TABLE 2

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

Configuration data	omnM0712.cfg	omnM0906.cfg	omnM1220.cfg	omnN0513.cfg
MTA	12/07/2007 23:01	06/09/2007 23:01	21/12/2007 00:01	13/05/2008 23:01
Orifice plate bore diameter (mm)	329.676	329.676	329.676	330.002
Expansion coefficient of the plate (°C)	0.000016	0.000016	0.000016	0.000016
Orifice plate calibration temperature	21	21	21	20
Meter tube diameter (mm)	581.1605	581.1605	581.1605	581.1605
Expansion coefficient of the meter tube (°C)	0.000011	0.000011	0.000011	0.000011
Meter tube calibration temperature	20	20	20	20
Isentropic Exponent	1.3469	1.3469	1.3469	1.3469
Dynamic Viscosity (Pa.s)	0.0000119	0.0000119	0.000012	0.000012
Orifice plate certificate number	OP70017	OP70017	OP70017	OP80016
Orifice plate serial number	549-2	549-2	549-2	548-1
Error in orifice diameter?	Yes	Yes	Yes	No
MTB				
Orifice plate bore diameter (mm)	329.559	329.559	329.559	329.8695
Expansion coefficient of the plate (°C)	0.000016	0.000016	0.000016	0.000016
Orifice plate calibration temperature	21	21	21	20
Meter tube diameter (mm)	580.4789	580.4789	580.4789	580.4789
Expansion coefficient of the meter tube (°C)	0	0.000011	0.000011	0.000011
Meter tube calibration temperature	20	20	20	20
Isentropic Exponent	1.3469	1.3469	1.3469	1.3469
Dynamic Viscosity (Pa.s)	0.0000119	0.0000119	0.000012	0.000012
Orifice plate certificate number	OP70018	OP70018	OP70018	OP80015
Orifice plate serial number	Lux-2-1	Lux-2-1	Lux-2-1	Lux-1-1
Error in orifice diameter?	Yes	Yes	Yes	No

In the configuration files for MTB the orifice plate calibration temperature has been entered wrongly on two occasions and the meter tube calibration expansion coefficient set to 0 for a period. The calculations given here give the correction due to mis-measurement of orifice diameter alone, not that due to these other errors.

### 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 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  $\varepsilon$  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 19/06/2007 to 12/07/2007 the correction on MTA can be calculated as in Table 3. Throughout this calculation the meter tube diameter is 581.1605 mm and the isentropic exponent is 1.3375 and the dynamic viscosity is 0.0000119 Pa s.

**TABLE 3**

**THE CORRECTION ON MTA FROM 19/06/2007 TO 12/07/2007**

	<i>d</i> mm	$\beta$	$\varepsilon$	$Re_D$	<i>C</i>	$\frac{q_{m,c}}{q_{m,o}}$
Original: $\Delta p=10$ mbar	329.6707	0.567263	0.999943	3197888	0.603893	
Corrected $\Delta p=10$ mbar	329.9857	0.567805	0.999943	3204739	0.603898	1.0021424
Original $\Delta p=500$ mbar	329.6707	0.567263	0.997173	22541384	0.603667	
Corrected $\Delta p=500$ mbar	329.9857	0.567805	0.997172	22589650	0.603672	1.0021412

So  $q_{m,c}/q_{m,o}$  is 1.002142.

Over the period from 19/06/2007 to 12/07/2007 the correction on MTB can be calculated as in Table 4. Throughout this calculation the meter tube diameter is 580.4789 mm and the isentropic exponent is 1.3375 and the dynamic viscosity is 0.0000119 Pa s.

**TABLE 4**

**THE CORRECTION ON MTB FROM 19/06/2007 TO 12/07/2007**

	<i>d</i> mm	$\beta$	$\varepsilon$	$Re_D$	<i>C</i>	$\frac{q_{m,c}}{q_{m,o}}$
Original: $\Delta p=10$ mbar	329.5537	0.567727	0.999943	3200004	0.603898	
Corrected $\Delta p=10$ mbar	329.8629	0.568260	0.999943	3206736	0.603903	1.0021038
Original $\Delta p=500$ mbar	329.5537	0.567727	0.997172	22556267	0.603672	
Corrected $\Delta p=500$ mbar	329.8629	0.568260	0.997171	22603695	0.603677	1.0021026

So  $q_{m,c}/q_{m,o}$  is 1.002103.

Over the period from 12/07/2007 to 20/12/2007 the correction on MTA can be calculated as in Table 5. Throughout this calculation the meter tube diameter is 581.1605 mm and the isentropic exponent is 1.3469 and the dynamic viscosity is 0.0000119 Pa s.

TABLE 5

## THE CORRECTION ON MTA FROM 12/07/2007 TO 20/12/2007

	$d$ mm	$\beta$	$\varepsilon$	$Re_D$	$C$	$\frac{q_{m,c}}{q_{m,o}}$
Original: $\Delta p=10$ mbar	329.6707	0.567263	0.999944	3197890	0.603893	
Corrected $\Delta p=10$ mbar	329.9857	0.567805	0.999944	3204741	0.603898	1.0021424
Original $\Delta p=500$ mbar	329.6707	0.567263	0.997192	22541830	0.603667	
Corrected $\Delta p=500$ mbar	329.9857	0.567805	0.997191	22590097	0.603672	1.0021412

So  $q_{m,c}/q_{m,o}$  is 1.002142.

Over the period from 12/07/2007 to 20/12/2007 the correction on MTB can be calculated as in Table 6. Throughout this calculation the meter tube diameter is 580.4789 mm and the isentropic exponent is 1.3469 and the dynamic viscosity is 0.0000119 Pa s.

TABLE 6

## THE CORRECTION ON MTB FROM 12/07/2007 TO 20/12/2007

	$d$ mm	$\beta$	$\varepsilon$	$Re_D$	$C$	$\frac{q_{m,c}}{q_{m,o}}$
Original: $\Delta p=10$ mbar	329.5537	0.567727	0.999944	3200005	0.603898	
Corrected $\Delta p=10$ mbar	329.8629	0.568260	0.999944	3206738	0.603903	1.0021038
Original $\Delta p=500$ mbar	329.5537	0.567727	0.997192	22556714	0.603672	
Corrected $\Delta p=500$ mbar	329.8629	0.568260	0.997191	22604143	0.603677	1.0021026

So  $q_{m,c}/q_{m,o}$  is 1.002103.

Over the period from 20/12/2007 to 13/05/2008 the correction on MTA can be calculated as in Table 7. Throughout this calculation the meter tube diameter is 581.1605 mm and the isentropic exponent is 1.3469 and the dynamic viscosity is 0.000012 Pa s.

TABLE 7

## THE CORRECTION ON MTA FROM 20/12/2007 TO 13/05/2008

	$d$ mm	$\beta$	$\varepsilon$	$Re_D$	$C$	$\frac{q_{m,c}}{q_{m,o}}$
Original: $\Delta p=10$ mbar	329.6707	0.567263	0.999944	3171250	0.603895	
Corrected $\Delta p=10$ mbar	329.9857	0.567805	0.999944	3178044	0.603900	1.0021424
Original $\Delta p=500$ mbar	329.6707	0.567263	0.997192	22353997	0.603667	
Corrected $\Delta p=500$ mbar	329.9857	0.567805	0.997191	22401862	0.603673	1.0021412

So  $q_{m,c}/q_{m,o}$  is 1.002142.

Over the period from 20/12/2007 to 13/05/2008 the correction on MTB can be calculated as in Table 8. Throughout this calculation the meter tube diameter is 580.4789 mm and the isentropic exponent is 1.3469 and the dynamic viscosity is 0.000012 Pa s.

TABLE 8

## THE CORRECTION ON MTB FROM 20/12/2007 TO 13/05/2008

	$d$ mm	$\beta$	$\varepsilon$	$Re_D$	$C$	$\frac{q_{m,c}}{q_{m,o}}$
Original: $\Delta p=10$ mbar	329.5537	0.567727	0.999944	3173348	0.603900	
Corrected $\Delta p=10$ mbar	329.8629	0.568260	0.999944	3180024	0.603905	1.0021038
Original $\Delta p=500$ mbar	329.5537	0.567727	0.997192	22368757	0.603672	
Corrected $\Delta p=500$ mbar	329.8629	0.568260	0.997191	22415791	0.603677	1.0021026

So  $q_{m,c}/q_{m,o}$  is 1.002103.

#### 4 CORRECTIONS ON A DAILY BASIS

Each (approximately four-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 the orifice plates in MTA and MTB were changed at 09:30.

## 5 CONCLUSIONS

Correction factors should be applied as shown in Table 9.

**TABLE 9**  
**CORRECTION FACTORS**

Meter tube	Date	Correction factor $q_{m,c}/q_{m,o}$
MTA	19/06/2007 to 13/05/2008	1.002142
MTB	19/06/2007 to 13/05/2008	1.002103

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 10.

**TABLE 10**  
**FLOW IN THE PERIOD 19/06/2007 TO 13/05/2008 INCLUSIVE**

	MTA	MTB
Flow (mscm)	762.38050	29.01457
Correction (mscm)	1.63291	0.06102
Corrected flow (mscm)	764.01341	29.07559
% change	0.2142	0.2103

**APPENDIX A  
ORIFICE PLATE CALIBRATION CERTIFICATES**

**TRANSCO ORIFICE PLATE CALIBRATION**

**DATE:** 16-05-05

**REF NO:** OP5107

**TEMPERATURE:** degsC

**MEASURED ORIFICE BORE:** 329.856mm

PLATE DETAILS

PLATE SERIAL.	LUX-2-1	PLATE O.D	647.702mm	SITE:	LUXBOROUGH LANE
MANUFACTURER:	HEECO	PIPE I.D:	mm	FLOW:	
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:- 4820 NEXT CAL DUE:- 15/10/05

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS:-	1	2	3	4	5		
FLATNESS %	0.033	0.047	0.048	0.047	0.046	0.025	0.041
'E' mm	12.700	12.690	12.690	12.694	12.696	12.689	12.686
'e' mm	4.622	4.700	4.753	4.753	4.691	4.615	4.521
EDGE SHARPNESS mm	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125
BEVEL ANGLE:	44 DEGS						
CONCENTRICITY	0.293mm						
SURFACE FINISH (Ra)	3.0 microns						

DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS

ROUNDNESS : 0.006mm TAPER: 0 degs

COMMENTS:

INSPECTED BY.....  ..... G.WARDLE

VERIFIED BY.....  ..... P.KENNERSON

**TRANSCO ORIFICE PLATE CALIBRATION**

**DATE:** 16-05-05

**REF NO:** OP5108

**TEMPERATURE:** 21 degsC

**MEASURED ORIFICE BORE:** 329.9805mm

PLATE DETAILS

PLATE SERIAL.	549-2	PLATE O.D	647.700mm		
MANUFACTURER:	HEECO	PIPE I.D:	mm	SITE	LUXBOROUGH LANE
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	2						8
FLATNESS %	0.002	0.009	0.010	0.003	0.028	0.012	0.014	0.011
'E' mm	12.870	12.853	12.842	12.847	12.860	12.860	12.861	12.863
'e' mm	5.347	5.328	5.329	5.328	5.332	5.344	5.324	5.324
EDGE SHARPNESS mm	0.0125	0.025	0.025	0.025	0.0125	0.025	0.0125	0.025
BEVEL ANGLE:	44 DEGS							
CONCENTRICITY	0.065mm							
SURFACE FINISH (Ra)	3.3 microns							
DOWNSTREAM FACE/EDGE VISUAL INSPECTION	PASS							
ROUNDNESS	0.012mm	TAPER	0 degs					

COMMENTS:

INSPECTED BY:  G. WARDLE

VERIFIED BY:  P. KENNERSON

## NATIONAL GRID ORIFICE PLATE CALIBRATION

**DATE:** 12-06-06  
**REF NO:** OP60091  
**TEMPERATURE:** 20 degsC  
  
**MEASURED ORIFICE BORE:** 329.986mm

### PLATE DETAILS

PLATE SERIAL.	549-2	PLATE O.D	647.706mm		
MANUFACTURER:		PIPE I.D:	575.04990mm	SITE:	LUXBOROUGH LANE
MATERIAL CERT.No.		DESIGN BORE:	mm	FLOW:	10.000.000 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:- 14/10/06

### UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS:-	1	2	3	4	5	6	7	8
FLATNESS $\mu$	0.001	0.017	0.016	0.004	0.010	0.005	0.017	0.014
E' mm	12.857	12.842	12.833	12.864	12.872	12.864	12.871	12.856
e' mm	5.339	5.331	5.330	5.337	5.338	5.341	5.325	5.327
EDGE SHARPNESS mm	0.0125	0.0125	SQUARE	0.0125	SQUARE	SQUARE	SQUARE	0.0125
BEVEL ANGLE	44 DEGS							
CONCENTRICITY	0.073mm							
SURFACE FINISH (Ra)	2.9 microns							

DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS

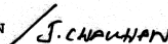
ROUNDNESS : 0.009mm TAPER: 0 degs

### COMMENTS:

INSPECTED BY.



P. KENNERSON



**NATIONAL GRID ORIFICE PLATE CALIBRATION**

**DATE:** 23-11-06  
**REF NO:** OP60101  
**TEMPERATURE:** 21 degsC

**MEASURED ORIFICE BORE:** 329.856mm

**PLATE DETAILS**

PLATE SERIAL. LUX-1-1 PLATE O.D 647.575mm  
 MANUFACTURER: PIPE I.D: mm SITE: LUXBOROUGH LANE  
 MATERIAL CERT.No. DESIGN BORE: mm FLOW:

**TEST EQUIPMENT**

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

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

STATIONS:-	1	2	3	4	5	6	7	8
FLATNESS %	0.199	0.233	0.243	0.232	0.200	0.145	0.082	0.127
mm	12.662	12.652	12.641	12.650	12.637	12.616	12.623	12.640
mm	4.778	4.681	4.514	4.465	4.557	4.742	4.920	4.856
EDGE SHARPNESS mm	SQUARE	SQUARE	0.0125	SQUARE	SQUARE	SQUARE	SQUARE	0.0125
BEVEL ANGLE:	45 DEGS							
CONCENTRICITY	0.096mm							
SURFACE FINISH (Ra)	2.0 microns							
DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS								
ROUNDNESS	0.011mm	TAPER: 0 degs						

COMMENTS:

INSPECTED BY.



P. KENNERSON



## NATIONAL GRID ORIFICE PLATE CALIBRATION

**DATE:** 23-11-06  
**REF NO:** OP60133  
**TEMPERATURE:** 20 degsC  
**MEASURED ORIFICE BORE:** 329.9965mm

### PLATE DETAILS

PLATE SERIAL:	548-1	PLATE O.D	647.691mm		
MANUFACTURER:		PIPE I.D:	575.0499mm	SITE:	LUXBOROUGH LANE
MATERIAL CERT.No.		DESIGN BORE:	329.9548mm	FLOW:	10*10E06 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:-	1	2	3	4	5	6	7	8
FLATNESS %	0.053	0.054	0.055	0.048	0.045	0.066	0.084	0.061
	12.832	12.810	12.835	12.890	12.880	12.856	12.869	12.866
mm	5.308	5.314	5.319	5.340	5.349	5.267	5.280	5.302
EDGE SHARPNESS mm	0.06	0.025	0.0125	0.0125	0.025	0.0125	0.0125	0.0125
BEVEL ANGLE:	44 DEGS							
CONCENTRICITY	0.027mm							
SURFACE FINISH (Ra)	3.84 microns							

DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS

ROUNDNESS 0.007mm TAPER: 0 degs

COMMENTS:

INSPECTED BY:



P. KENNERSON

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 08-06-07  
 REF NO: OP70017  
 TEMPERATURE: 21 degsC

MEASURED ORIFICE BORE: 329.676mm

PLATE DETAILS

PLATE SERIAL. 549-2 PLATE O.D 647.071mm  
 MANUFACTURER: PIPE I.D: mm SITE: LUXBOROUGH LANE  
 MATERIAL CERT.No DESIGN BORE mm FLOW:


TEST EQUIPMENT

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

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS	1	2	3	4	5	6	7	8
FLATNESS %	0.007	0.003	0.005	0.007	0.004	0.023	0.010	0.004
E mm	12.919	12.841	12.832	12.909	12.916	12.845	12.842	12.916
mm	5.365	5.327	5.327	5.375	5.378	5.326	5.316	5.365
EDGE SHARPNESS mm	SQ	SQ	0.0125	SQ	0.0125	SQ	0.0125	SQ
BEVEL ANGLE	44 DEGS							
CONCENTRICITY	0.269mm							
SURFACE FINISH (Ra)	2.8 microns							
DOWNSTREAM FACE/EDGE VISUAL INSPECTION	PASS							
ROUNDNESS 0.305mm	TAPER		0 degs					

COMMENTS

INSPECTED BY:  J. CHAWHAN

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 08-06-07  
 REF NO: OP70018  
 TEMPERATURE: 21 degsC

MEASURED ORIFICE BORE: 329.559mm

PLATE DETAILS

PLATE SERIAL. LUX-2-1                      PLATE O.D. 647.162mm  
 MANUFACTURER:                              PIPE I.D.: mm                      SITE: LUXBOROUGH LANE  
 MATERIAL CERT.No.                              DESIGN BORE: mm                      FLOW:

TEST EQUIPMENT

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

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS:-	1	2	3	4	5	6	7	8
FLATNESS %	0.043	0.053	0.042	0.043	0.041	0.039	0.037	0.030
'E' mm	12.756	12.682	12.678	12.755		12.670	12.671	12.761
'e' mm	4.641	4.691	4.746	4.778			4.614	
EDGE SHARPNESS mm	SQ	SQ	0.0125	0.0125	SQ	0.0125	SQ	SQ
BEVEL ANGLE:	44 DEGS							
CONCENTRICITY	0.246mm							
SURFACE FINISH (Ra)	1.1 microns							
DOWNSTREAM FACE/EDGE VISUAL INSPECTION	PASS							
ROUNDNESS :	0.304mm	TAPER:		0 degs				

COMMENTS:

INSPECTED BY:



P. KENNERSON

J. CHAUHAN

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 12-MAY-2008  
 REF NO: OP80015  
 TEMPERATURE: 20 degsC

MEASURED ORIFICE BORE: 329.8695mm

PLATE DETAILS

PLATE SERIAL: LUX-1-1 PLATE O.D: 647.557mm  
 MANUFACTURER: DANIEL PIPE I.D: 581.1605mm SITE: LUXBOROUGH LANE  
 MATERIAL CERT.No. 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:- 6292 NEXT CAL DUE:- 05-OCTOBER-2008

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS:-	1	2	3	4	5	6	7	8
FLATNESS %	0.076	0.040	0.062	0.122	0.113	0.157	0.090	0.027
mm	12.637	12.642	12.645	12.631	12.611	12.613	12.635	12.641
Re mm	4.685	4.564	4.453	4.481	4.668	4.883	4.873	4.773
EDGE SHARPNESS mm	0.025	0.0125	0.025	0.0125	0.0125	0.0125	0.0125	0.0125
BEVEL ANGLE:	45 DEGS							
CONCENTRICITY	26.751mm							
SURFACE FINISH (Ra)	2.05 microns							

DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS

ROUNDNESS 0.006mm TAPER 0 degs

COMMENTS: CLEAN PLATE.

INSPECTED BY:  M Livingstone

## NATIONAL GRID ORIFICE PLATE CALIBRATION

**DATE:** 12-MAY-2008

**REF NO:** OP80016

**TEMPERATURE:** 20 degsC

**MEASURED ORIFICE BORE:** 330.002mm

**PLATE DETAILS**

PLATE SERIAL.	548-1	PLATE O.D	647.674mm	SITE:	LUXBOROUGH LANE
MANUFACTURER:		PIPE I.D:	mm	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 %	0.101	0.078	0.065	0.052	0.048	0.061	0.160	0.115
'E' mm	12.810	12.820	12.853	12.877	12.858	12.863	12.877	12.857
'e' mm	5.296	5.314	5.319	5.309	5.321	5.294	5.276	5.308
EDGE SHARPNESS mm	0.025	0.025	0.025	0.0125	0.025	0.025	0.0125	0.0125
BEVEL ANGLE	44 DEGS							
CONCENTRICITY	0.023mm							
SURFACE FINISH (Ra)	2.5 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: 11-JULY-2008  
 REF NO: OP80037  
 TEMPERATURE: 20 degsC

MEASURED ORIFICE BORE: 329.996mm

PLATE DETAILS

PLATE SERIAL. 549-2 PLATE O.D 647.733mm  
 MANUFACTURER: PIPE I.D: 580.4789mm SITE: LUXBOROUGH LANE  
 MATERIAL CERT.No. DESIGN BORE: mm FLOW: 10X10E06 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:- 6292. NEXT CAL DUE:- 05-OCTOBER-2008

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS:-	1	2	3	4	5	6	7	8
FLATNESS %	0.006	0.004	0.005	0.003	0.000	0.012	0.028	0.006
'E' mm	12.855	12.852	12.840	12.842	12.849	12.872	12.865	12.851
'e' mm	5.333	5.328	5.317	5.322	5.318	5.337	5.315	5.316
EDGE SHARPNESS mm	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
BEVEL ANGLE	44 DEGS							
CONCENTRICITY	0.046mm							
SURFACE FINISH (Ra)	2.5 microns							

DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS

ROUNDNESS 0.008mm TAPER: 0 degs

DRAINHOLE PRESENT ? (YES/NO): No

COMMENTS: CLEAN PLATE

INSPECTED BY...  M Livingstone

NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 14-JULY-2008

REF NO: OP80039

TEMPERATURE: 20 degsC

MEASURED ORIFICE BORE: 329.875mm

PLATE DETAILS

PLATE SERIAL:	LUX-2-1	PLATE O.D.	647.689mm		
MANUFACTURER:	HEECO	PIPE I.D.:	581.1605mm	SITE:	LUXBOROUGH LANE
MATERIAL CERT.No.		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, 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 %	0.030	0.047	0.049	0.043	0.040	0.045	0.040	0.025
HT mm	12.683	12.692	12.692	12.695	12.695	12.689	12.689	12.691
	4.626	4.696	4.758	4.744	4.681	4.603	4.526	4.547
EDGE SHARPNESS mm	SQUARE	0.0125	0.0125	SQUARE	SQUARE	0.0125	SQUARE	SQUARE
BEVEL ANGLE:	44 DEGS							
CONCENTRICITY	0.306mm							
SURFACE FINISH (Ra)	1.2 microns							
DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS								
ROUNDNESS	0.008mm	TAPER:		0 degs				

DRAINHOLE PRESENT ? (YES/NO) No

COMMENTS: CLEAN PLATE

INSPECTED BY.....  M Livingstone.

**NATIONAL GRID ORIFICE PLATE CALIBRATION**

**DATE:** 21-MAY-2009  
**REF NO:** OP90015  
**TEMPERATURE:** 20.5 degsC

**MEASURED ORIFICE BORE:** 329.8635mm

PLATE DETAILS

PLATE SERIAL. LUX-1-1 PLATE O.D 647.578mm  
 MANUFACTURER: PIPE I.D: 851.1605mm SITE: LUXBOROUGH LANE  
 MATERIAL CERT.No. 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, UKAS CERT:- 6822. NEXT CAL DUE:- 03-OCTOBER-2009

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS:-	1	2	3	4	5	6	7	8
PLATNESS %	0.101	0.180	0.188	0.182	0.186	0.183	0.152	0.103
'E' mm	12.652	12.640	12.635	12.641	12.628	12.608	12.620	12.642
	4.749	4.690	4.499	4.443	4.581	4.726	4.917	4.852
EDGE SHARPNESS mm	0.0125	0.0125	0.025	0.025	0.0125	0.025	0.0125	0.0125
BEVEL ANGLE	45 DEGS							
CONCENTRICITY	0.088mm							
SURFACE FINISH (Ra)	1.9 microns							

DOWNSTREAM FACE/EDGE VISUAL INSPECTION :- PASS

ROUNDNESS : 0.012mm TAPER: 0 degs

DRAINHOLE PRESENT ? (YES/NO) No

COMMENTS: CLEAN PLATE

INSPECTED BY:  M Livingstone.



NATIONAL GRID ORIFICE PLATE CALIBRATION

DATE: 28-MAY-2009  
 REF NO: OP90016  
 TEMPERATURE: 20.6 degsC

MEASURED ORIFICE BORE: 329.997mm

PLATE DETAILS

PLATE SERIAL: 548-1 PLATE O.D: 647.688mm  
 MANUFACTURER: PIPE I.D: 580.4789mm SITE: LUXBOROUGH LANE  
 MATERIAL CERT.No: DESIGN BORE: mm FLOW: M<sup>3</sup>/DAY

TEST EQUIPMENT

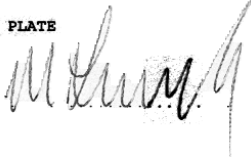
MANUFACTURER & TYPE: KEMCO 700 MANUAL 3-DIMENSIONAL MEASURING MACHINE -ASSET NO OP-A02  
 CALIBRATED BY: QUALITY CONTROL TECHNOLOGY, UKAS CERT:- 6822. NEXT CAL DUE:- 03-OCTOBER-2009

UPSTREAM FACE INSPECTION RESULTS (ISO 5167)

STATIONS:-	1	2	3	4				
FLATNESS %	0.069	0.042	0.049	0.044	0.037	0.074	0.080	0.061
'E' mm	12.822	12.812	12.847	12.870	12.848	12.857	12.871	12.862
		5.300	5.329	5.312	5.311	5.304	5.287	5.295
EDGE SHARPNESS mm	0.025	0.025	0.025	0.025	0.025	0.025	0.0125	0.0125
BEVEL ANGLE	44 DEGS							
CONCENTRICITY	0.049mm							
SURFACE FINISH (Ra)	2.45 microns							
DOWNSTREAM FACE/EDGE VISUAL INSPECTION	PASS							
ROUNDNESS 0.003mm	TAPER: 0 degs							

DRAINHOLE PRESENT ? (YES/NO)

COMMENTS: LEAN PLATE

INSPECTED BY  M Livingstone.

## APPENDIX B

### CORRECTED DAILY VOLUME FLOWS

TABLE B.1

#### FLOWS AT LUXBOROUGH LANE DURING THE PERIOD OF THE MIS-MEASUREMENT

	Original Values (total)	Corrected values (total)	% increase
Date	Volume (mscm)	Volume (mscm)	Volume (mscm)
19/6/2007	0.08200	<b>0.08218</b>	0.2135
20/6/2007	0.00000	<b>0.00000</b>	
21/6/2007	0.00000	<b>0.00000</b>	
22/6/2007	0.00000	<b>0.00000</b>	
23/6/2007	0.00000	<b>0.00000</b>	
24/6/2007	0.00000	<b>0.00000</b>	
25/6/2007	0.07600	<b>0.07616</b>	0.2142
26/6/2007	0.29300	<b>0.29363</b>	0.2142
27/6/2007	0.00000	<b>0.00000</b>	
28/6/2007	0.07500	<b>0.07516</b>	0.2103
29/6/2007	0.06900	<b>0.06915</b>	0.2142
30/6/2007	0.00000	<b>0.00000</b>	
1/7/2007	0.00000	<b>0.00000</b>	
2/7/2007	0.36500	<b>0.36578</b>	0.2138
3/7/2007	0.34400	<b>0.34474</b>	0.2142
4/7/2007	0.00000	<b>0.00000</b>	
5/7/2007	0.00000	<b>0.00000</b>	
6/7/2007	0.07400	<b>0.07416</b>	0.2142
7/7/2007	0.00000	<b>0.00000</b>	
8/7/2007	0.00000	<b>0.00000</b>	
9/7/2007	0.00000	<b>0.00000</b>	
10/7/2007	0.00000	<b>0.00000</b>	
11/7/2007	0.00000	<b>0.00000</b>	
12/7/2007	0.00000	<b>0.00000</b>	
13/7/2007	0.00000	<b>0.00000</b>	
14/7/2007	0.00000	<b>0.00000</b>	
15/7/2007	0.00000	<b>0.00000</b>	
16/7/2007	0.00000	<b>0.00000</b>	
17/7/2007	0.00000	<b>0.00000</b>	
18/7/2007	0.00000	<b>0.00000</b>	
19/7/2007	0.00000	<b>0.00000</b>	
20/7/2007	0.00000	<b>0.00000</b>	
21/7/2007	0.00000	<b>0.00000</b>	
22/7/2007	0.00100	<b>0.00100</b>	0.2142
23/7/2007	0.00000	<b>0.00000</b>	
24/7/2007	0.00000	<b>0.00000</b>	
25/7/2007	0.00000	<b>0.00000</b>	
26/7/2007	0.00000	<b>0.00000</b>	
27/7/2007	0.00000	<b>0.00000</b>	
28/7/2007	0.00000	<b>0.00000</b>	
29/7/2007	0.00000	<b>0.00000</b>	

**TUV NEL**

30/7/2007	0.02600	<b>0.02606</b>	0.2142
31/7/2007	0.00000	<b>0.00000</b>	
1/8/2007	0.00000	<b>0.00000</b>	
2/8/2007	0.00000	<b>0.00000</b>	
3/8/2007	0.00000	<b>0.00000</b>	
4/8/2007	0.00000	<b>0.00000</b>	
5/8/2007	0.00000	<b>0.00000</b>	
6/8/2007	0.00000	<b>0.00000</b>	
7/8/2007	0.00000	<b>0.00000</b>	
8/8/2007	0.00000	<b>0.00000</b>	
9/8/2007	0.00000	<b>0.00000</b>	
10/8/2007	0.00000	<b>0.00000</b>	
11/8/2007	0.00000	<b>0.00000</b>	
12/8/2007	0.00100	<b>0.00100</b>	0.2142
13/8/2007	0.00000	<b>0.00000</b>	
14/8/2007	0.00000	<b>0.00000</b>	
15/8/2007	0.00000	<b>0.00000</b>	
16/8/2007	0.00000	<b>0.00000</b>	
17/8/2007	0.00000	<b>0.00000</b>	
18/8/2007	0.00000	<b>0.00000</b>	
19/8/2007	0.00000	<b>0.00000</b>	
20/8/2007	0.00000	<b>0.00000</b>	
21/8/2007	0.00000	<b>0.00000</b>	
22/8/2007	0.00000	<b>0.00000</b>	
23/8/2007	0.00000	<b>0.00000</b>	
24/8/2007	0.00000	<b>0.00000</b>	
25/8/2007	0.00000	<b>0.00000</b>	
26/8/2007	0.00000	<b>0.00000</b>	
27/8/2007	0.00000	<b>0.00000</b>	
28/8/2007	0.00100	<b>0.00100</b>	0.2142
29/8/2007	0.00100	<b>0.00100</b>	0.2142
30/8/2007	0.00000	<b>0.00000</b>	
31/8/2007	0.00000	<b>0.00000</b>	
1/9/2007	0.00000	<b>0.00000</b>	
2/9/2007	0.00000	<b>0.00000</b>	
3/9/2007	0.00000	<b>0.00000</b>	
4/9/2007	0.00000	<b>0.00000</b>	
5/9/2007	0.05300	<b>0.05311</b>	0.2142
6/9/2007	0.08100	<b>0.08117</b>	0.2142
7/9/2007	0.00100	<b>0.00100</b>	0.2142
8/9/2007	0.00000	<b>0.00000</b>	
9/9/2007	0.00000	<b>0.00000</b>	
10/9/2007	0.06900	<b>0.06915</b>	0.2142
11/9/2007	0.00000	<b>0.00000</b>	
12/9/2007	0.00000	<b>0.00000</b>	
13/9/2007	0.00000	<b>0.00000</b>	
14/9/2007	0.00000	<b>0.00000</b>	
15/9/2007	0.00000	<b>0.00000</b>	
16/9/2007	0.00000	<b>0.00000</b>	
17/9/2007	0.00000	<b>0.00000</b>	

**TUV NEL**

18/9/2007	0.00000	<b>0.00000</b>	
19/9/2007	0.00000	<b>0.00000</b>	
20/9/2007	0.00000	<b>0.00000</b>	
21/9/2007	0.00000	<b>0.00000</b>	
22/9/2007	0.00000	<b>0.00000</b>	
23/9/2007	0.00000	<b>0.00000</b>	
24/9/2007	0.00000	<b>0.00000</b>	
25/9/2007	0.00100	<b>0.00100</b>	0.2142
26/9/2007	0.00000	<b>0.00000</b>	
27/9/2007	0.00000	<b>0.00000</b>	
28/9/2007	0.00000	<b>0.00000</b>	
29/9/2007	0.00000	<b>0.00000</b>	
30/9/2007	0.00000	<b>0.00000</b>	
1/10/2007	0.00000	<b>0.00000</b>	
2/10/2007	0.16100	<b>0.16134</b>	0.2142
3/10/2007	0.00100	<b>0.00100</b>	0.2142
4/10/2007	0.00000	<b>0.00000</b>	
5/10/2007	0.00000	<b>0.00000</b>	
6/10/2007	0.00100	<b>0.00100</b>	0.2142
7/10/2007	0.00000	<b>0.00000</b>	
8/10/2007	0.00000	<b>0.00000</b>	
9/10/2007	0.00000	<b>0.00000</b>	
10/10/2007	0.00100	<b>0.00100</b>	0.2103
11/10/2007	0.00000	<b>0.00000</b>	
12/10/2007	0.00000	<b>0.00000</b>	
13/10/2007	0.00100	<b>0.00100</b>	0.2142
14/10/2007	0.00000	<b>0.00000</b>	
15/10/2007	0.00000	<b>0.00000</b>	
16/10/2007	0.00000	<b>0.00000</b>	
17/10/2007	0.00000	<b>0.00000</b>	
18/10/2007	0.00000	<b>0.00000</b>	
19/10/2007	0.00000	<b>0.00000</b>	
20/10/2007	0.00000	<b>0.00000</b>	
21/10/2007	0.00100	<b>0.00100</b>	0.2142
22/10/2007	0.00000	<b>0.00000</b>	
23/10/2007	0.00000	<b>0.00000</b>	
24/10/2007	0.00000	<b>0.00000</b>	
25/10/2007	0.00000	<b>0.00000</b>	
26/10/2007	0.00000	<b>0.00000</b>	
27/10/2007	0.00000	<b>0.00000</b>	
28/10/2007	0.00000	<b>0.00000</b>	
29/10/2007	0.00000	<b>0.00000</b>	
30/10/2007	0.00000	<b>0.00000</b>	
31/10/2007	0.00000	<b>0.00000</b>	
1/11/2007	0.00000	<b>0.00000</b>	
2/11/2007	0.00100	<b>0.00100</b>	0.2142
3/11/2007	0.00000	<b>0.00000</b>	
4/11/2007	0.00000	<b>0.00000</b>	
5/11/2007	0.00000	<b>0.00000</b>	
6/11/2007	0.00000	<b>0.00000</b>	

7/11/2007	0.09700	<b>0.09721</b>	0.2142
8/11/2007	0.00000	<b>0.00000</b>	
9/11/2007	0.00000	<b>0.00000</b>	
10/11/2007	0.00000	<b>0.00000</b>	
11/11/2007	0.00000	<b>0.00000</b>	
12/11/2007	0.00000	<b>0.00000</b>	
13/11/2007	0.00000	<b>0.00000</b>	
14/11/2007	0.00000	<b>0.00000</b>	
15/11/2007	0.00000	<b>0.00000</b>	
16/11/2007	0.00000	<b>0.00000</b>	
17/11/2007	0.00000	<b>0.00000</b>	
18/11/2007	0.00000	<b>0.00000</b>	
19/11/2007	0.00100	<b>0.00100</b>	0.2142
20/11/2007	0.20100	<b>0.20143</b>	0.2142
21/11/2007	0.00000	<b>0.00000</b>	
22/11/2007	0.00000	<b>0.00000</b>	
23/11/2007	2.48700	<b>2.49233</b>	0.2142
24/11/2007	5.69000	<b>5.70219</b>	0.2142
25/11/2007	5.97900	<b>5.99181</b>	0.2142
26/11/2007	5.99100	<b>6.00383</b>	0.2142
27/11/2007	5.14800	<b>5.15903</b>	0.2142
28/11/2007	5.71500	<b>5.72724</b>	0.2142
29/11/2007	5.60700	<b>5.61901</b>	0.2142
30/11/2007	5.58100	<b>5.59295</b>	0.2142
1/12/2007	4.99300	<b>5.00370</b>	0.2142
2/12/2007	4.98600	<b>4.99668</b>	0.2142
3/12/2007	5.22100	<b>5.23218</b>	0.2142
4/12/2007	5.26800	<b>5.27928</b>	0.2142
5/12/2007	5.20901	<b>5.22017</b>	0.2142
6/12/2007	5.36500	<b>5.37649</b>	0.2142
7/12/2007	6.67000	<b>6.68429</b>	0.2142
8/12/2007	7.19901	<b>7.21443</b>	0.2142
9/12/2007	7.29400	<b>7.30962</b>	0.2142
10/12/2007	6.65100	<b>6.66525</b>	0.2142
11/12/2007	7.68400	<b>7.70046</b>	0.2142
12/12/2007	6.12100	<b>6.13411</b>	0.2142
13/12/2007	6.35999	<b>6.37361</b>	0.2142
14/12/2007	5.00200	<b>5.01271</b>	0.2142
15/12/2007	5.21101	<b>5.22217</b>	0.2142
16/12/2007	5.28400	<b>5.29532</b>	0.2142
17/12/2007	6.31500	<b>6.32853</b>	0.2142
18/12/2007	5.75499	<b>5.76732</b>	0.2142
19/12/2007	5.76601	<b>5.77836</b>	0.2142
20/12/2007	5.31799	<b>5.32938</b>	0.2142
21/12/2007	8.08501	<b>8.10233</b>	0.2142
22/12/2007	7.00700	<b>7.02201</b>	0.2142
23/12/2007	6.99800	<b>7.01299</b>	0.2142
24/12/2007	5.49300	<b>5.50477</b>	0.2142
25/12/2007	5.49600	<b>5.50777</b>	0.2142
26/12/2007	5.23399	<b>5.24520</b>	0.2142

27/12/2007	5.24701	<b>5.25825</b>	0.2142
28/12/2007	5.31999	<b>5.33139</b>	0.2142
29/12/2007	5.31200	<b>5.32338</b>	0.2142
30/12/2007	5.51201	<b>5.52382</b>	0.2142
31/12/2007	5.37199	<b>5.38350</b>	0.2142
1/1/2008	6.25801	<b>6.27141</b>	0.2142
2/1/2008	6.98099	<b>6.99592</b>	0.2138
3/1/2008	9.47000	<b>9.49010</b>	0.2122
4/1/2008	7.23401	<b>7.24936</b>	0.2122
5/1/2008	6.30600	<b>6.31938</b>	0.2122
6/1/2008	6.30600	<b>6.31938</b>	0.2122
7/1/2008	6.58600	<b>6.59998</b>	0.2122
8/1/2008	6.74399	<b>6.75830</b>	0.2122
9/1/2008	6.28403	<b>6.29737</b>	0.2122
10/1/2008	5.79700	<b>5.80942</b>	0.2142
11/1/2008	5.20200	<b>5.21314</b>	0.2142
12/1/2008	5.83499	<b>5.84749</b>	0.2142
13/1/2008	6.64001	<b>6.65423</b>	0.2142
14/1/2008	6.16998	<b>6.18320</b>	0.2142
15/1/2008	6.19299	<b>6.20626</b>	0.2142
16/1/2008	6.10703	<b>6.12011</b>	0.2142
17/1/2008	9.02600	<b>9.04520</b>	0.2127
18/1/2008	5.30499	<b>5.31635</b>	0.2142
19/1/2008	5.29099	<b>5.30232</b>	0.2142
20/1/2008	5.07202	<b>5.08288</b>	0.2142
21/1/2008	5.33600	<b>5.34743</b>	0.2142
22/1/2008	6.39099	<b>6.40468</b>	0.2142
23/1/2008	5.03400	<b>5.04478</b>	0.2142
24/1/2008	5.10602	<b>5.11696</b>	0.2142
25/1/2008	5.27499	<b>5.28629</b>	0.2142
26/1/2008	5.01199	<b>5.02273</b>	0.2142
27/1/2008	5.16199	<b>5.17305</b>	0.2142
28/1/2008	6.30600	<b>6.31951</b>	0.2142
29/1/2008	5.98502	<b>5.99784</b>	0.2142
30/1/2008	6.31500	<b>6.32853</b>	0.2142
31/1/2008	6.70999	<b>6.72436</b>	0.2142
1/2/2008	6.83899	<b>6.85364</b>	0.2142
2/2/2008	6.74103	<b>6.75547</b>	0.2142
3/2/2008	6.73300	<b>6.74742</b>	0.2142
4/2/2008	6.49399	<b>6.50790</b>	0.2142
5/2/2008	6.50400	<b>6.51793</b>	0.2142
6/2/2008	6.48599	<b>6.49988</b>	0.2142
7/2/2008	5.99402	<b>6.00686</b>	0.2142
8/2/2008	6.31000	<b>6.32352</b>	0.2142
9/2/2008	6.30200	<b>6.31550</b>	0.2142
10/2/2008	6.31799	<b>6.33152</b>	0.2142
11/2/2008	6.32501	<b>6.33856</b>	0.2142
12/2/2008	6.59900	<b>6.61314</b>	0.2142
13/2/2008	6.71899	<b>6.73338</b>	0.2142
14/2/2008	6.99301	<b>7.00799</b>	0.2142

15/2/2008	6.25696	<b>6.27036</b>	0.2142
16/2/2008	5.98303	<b>5.99585</b>	0.2142
17/2/2008	5.98499	<b>5.99781</b>	0.2142
18/2/2008	6.42798	<b>6.44175</b>	0.2142
19/2/2008	6.33801	<b>6.35159</b>	0.2142
20/2/2008	6.25299	<b>6.26638</b>	0.2142
21/2/2008	5.74701	<b>5.75932</b>	0.2142
22/2/2008	5.03503	<b>5.04582</b>	0.2142
23/2/2008	4.99799	<b>5.00870</b>	0.2142
24/2/2008	5.04401	<b>5.05481</b>	0.2142
25/2/2008	5.25702	<b>5.26828</b>	0.2142
26/2/2008	5.23596	<b>5.24718</b>	0.2142
27/2/2008	5.08600	<b>5.09689</b>	0.2142
28/2/2008	5.13300	<b>5.14399</b>	0.2142
29/2/2008	6.65100	<b>6.66525</b>	0.2142
1/3/2008	6.29401	<b>6.30749</b>	0.2142
2/3/2008	5.96399	<b>5.97676</b>	0.2142
3/3/2008	6.75104	<b>6.76550</b>	0.2142
4/3/2008	6.73499	<b>6.74942</b>	0.2142
5/3/2008	6.92603	<b>6.94087</b>	0.2142
6/3/2008	5.16095	<b>5.17200</b>	0.2142
7/3/2008	6.08002	<b>6.09304</b>	0.2142
8/3/2008	6.17499	<b>6.18822</b>	0.2142
9/3/2008	6.19800	<b>6.21128</b>	0.2142
10/3/2008	7.00403	<b>7.01903</b>	0.2142
11/3/2008	6.00397	<b>6.01683</b>	0.2142
12/3/2008	6.65302	<b>6.66727</b>	0.2142
13/3/2008	6.75903	<b>6.77351</b>	0.2142
14/3/2008	5.00598	<b>5.01670</b>	0.2142
15/3/2008	3.77698	<b>3.78507</b>	0.2142
16/3/2008	5.08600	<b>5.09689</b>	0.2142
17/3/2008	7.61102	<b>7.62732</b>	0.2142
18/3/2008	6.99701	<b>7.01200</b>	0.2142
19/3/2008	5.99298	<b>6.00582</b>	0.2142
20/3/2008	5.99500	<b>6.00784</b>	0.2142
21/3/2008	6.23804	<b>6.25140</b>	0.2142
22/3/2008	7.16498	<b>7.18033</b>	0.2142
23/3/2008	6.77600	<b>6.79051</b>	0.2142
24/3/2008	6.72101	<b>6.73541</b>	0.2142
25/3/2008	6.77502	<b>6.78953</b>	0.2142
26/3/2008	6.48999	<b>6.50389</b>	0.2142
27/3/2008	6.49298	<b>6.50689</b>	0.2142
28/3/2008	6.68597	<b>6.70029</b>	0.2142
29/3/2008	0.00000	<b>0.00000</b>	
30/3/2008	0.00000	<b>0.00000</b>	
31/3/2008	0.00000	<b>0.00000</b>	
1/4/2008	0.00000	<b>0.00000</b>	
2/4/2008	0.00000	<b>0.00000</b>	
3/4/2008	0.00000	<b>0.00000</b>	
4/4/2008	0.00000	<b>0.00000</b>	

TUV NEL

5/4/2008	0.00104	<b>0.00104</b>	0.2142
6/4/2008	0.05701	<b>0.05713</b>	0.2142
7/4/2008	0.02301	<b>0.02306</b>	0.2142
8/4/2008	0.21899	<b>0.21946</b>	0.2142
9/4/2008	0.00000	<b>0.00000</b>	
10/4/2008	0.00000	<b>0.00000</b>	
11/4/2008	0.00000	<b>0.00000</b>	
12/4/2008	0.00000	<b>0.00000</b>	
13/4/2008	0.00000	<b>0.00000</b>	
14/4/2008	0.00098	<b>0.00098</b>	0.2142
15/4/2008	0.00000	<b>0.00000</b>	
16/4/2008	0.00000	<b>0.00000</b>	
17/4/2008	0.00000	<b>0.00000</b>	
18/4/2008	0.00000	<b>0.00000</b>	
19/4/2008	0.00098	<b>0.00098</b>	0.2103
20/4/2008	0.00000	<b>0.00000</b>	
21/4/2008	0.00000	<b>0.00000</b>	
22/4/2008	0.00000	<b>0.00000</b>	
23/4/2008	0.00000	<b>0.00000</b>	
24/4/2008	0.00000	<b>0.00000</b>	
25/4/2008	0.83301	<b>0.83479</b>	0.2142
26/4/2008	0.00000	<b>0.00000</b>	
27/4/2008	0.00000	<b>0.00000</b>	
28/4/2008	0.00000	<b>0.00000</b>	
29/4/2008	0.00000	<b>0.00000</b>	
30/4/2008	0.00104	<b>0.00104</b>	0.2142
1/5/2008	0.00000	<b>0.00000</b>	
2/5/2008	3.43298	<b>3.44033</b>	0.2142
3/5/2008	2.77899	<b>2.78494</b>	0.2142
4/5/2008	2.59503	<b>2.60059</b>	0.2142
5/5/2008	2.76794	<b>2.77387</b>	0.2142
6/5/2008	2.12903	<b>2.13359</b>	0.2142
7/5/2008	2.35797	<b>2.36302</b>	0.2142
8/5/2008	1.87402	<b>1.87803</b>	0.2142
9/5/2008	0.47498	<b>0.47600</b>	0.2142
10/5/2008	0.00000	<b>0.00000</b>	
11/5/2008	0.00000	<b>0.00000</b>	
12/5/2008	0.00000	<b>0.00000</b>	
13/5/2008	0.08301	<b>0.08308</b>	0.0837