Methodology used in the Survey of Diffusion Tube Collocation Studies

1.1 In order to assist air quality practitioners adjust their diffusion tubes for bias, Air Quality Consultants Ltd has been commissioned by Defra and the Devolved Administrations to collate data from nitrogen dioxide diffusion tube collocation studies across the UK. For several years now, questionnaires have been sent to Local Authorities asking them to supply data from collocation studies with at least 9 months data.

1.2 Prior to 2005, the questionnaire asked only for annual mean concentration data. Because of requests from users of the survey results, in early 2005, the questionnaire was extended to include a request for monthly data.

1.3 Page 2 of this document presents an example of a questionnaire that has been completed.

1.4 For statistical reasons, it is NOT appropriate to simply average adjustment factors. The most appropriate method of combining factors is to use orthogonal regression. This is the approach used throughout this survey. Details of this approach are given on Page 3 of this document. Averaging of BIAS factors gives a close approximation to the results from orthogonal regression so can be used if necessary to add local collocation results (see Page 3).

Example of a completed questionnaire

Diffusion Tube Collocation Data Questionnaire For Local Authorities 2006

Please Read the "Notes" sheet and then fill in the white boxes of this questionnaire
Should you require assistance, email denisewelch@aqconsultants.co.uk or phone 0117 974 1086

Your Details	Date form filled in	Name of Local Authority	Your name	Phone number	Contact email
	10.02.06	Barnsley Metropolitan Borough Council	Chris Shields	01226 772452	chrisshields@barnsley.gov.uk

Site Details	Distance from kerb (m)	Site type (e.g. roadside, background). Definitions of site types are given on the "Notes" sheet	Distance from diffusion tube(s) to continuous analyser inlet (m)	Location (site name or a brief description)	Grid Reference of Site (if available)
	3.5	Roadside	0.2	Barnsley A628 Roadside	432680 406174

Diffusion Tube Details	Prepared by (if known; e.g. Harwell Scientific Services)	Analysed by (e.g. Kent Scientific Services)	Preparation method (e.g. 50% TEA in acetone; 50% TEA in water)	How are diffusion tubes deployed? (e.g. with a clip, spacer, shelter box, just tape)
	Gradko	South Yorkshire Laboratory	50% TEA in acetone	Circular clip and spacer bar

Continuous Analyser Details	Analyser type	QA/QC (e.g. local or network)
	AP1 Model 200 Chemilumenescence analyser	Netcen Calibration Club who also ratify the data

Data from the Automatic Analyser (Matching Individual Diffusion Tube Periods)

Period	Start Date (dd/mm/yy)	End Date (dd/mm/yy)	% Data Capture	Ratified / Provisional	NOx (if available) (ug/m^3)	Nitrogen Dioxide (ug/m^3)
1	04/01/2005	01/02/2005	95.5	Ratified	87	40
2	02/02/2005	01/03/2005	91.3	Ratified	104	46
3	02/03/2005	29/03/2005	95.1	Ratified	87	44
4	30/03/2005	03/05/2005	95.5	Ratified	101	50
5	04/05/2005	31/05/2005	95.5	Ratified	76	38
6	01/06/2005	28/06/2005	95.5	Ratified	85	41
7	29/06/2005	02/08/2005	95.6	Ratified	83	38
8	03/08/2005	30/08/2005	93.1	Ratified	79	36
9	31/08/2005	04/10/2005	82.4	Ratified	112	46
10	05/10/2005	01/11/2005	99.6	Ratified	113	50
11	02/11/2005	29/11/2005	99.4	Ratified	131	49
12	30/11/2005	03/01/2006	99.6	Ratified (Prov 010106-030106)	129	51

Please express NOx as NO_2 (e.g. ppb x 1.913) or alternatively note the approach / units here:

When you are identifying the automatic monitoring periods that match your diffusion tube exposure periods, please be as precise as possible. It is not, however, necessary to match start times to the exact hour that you put out your tubes.

Individual Period (monthly) Mean Nitrogen Dioxide Data from the Diffusion Tubes (ug/m^3)

Period		Tube 1	Tube 2 (if available)	Tube 3 (if available)	Tube 4 (if available)
1		46	45	48	
2		47	45	48	
3		47	43	48	
4		47	30	51	
5		33	33	33	
6		38	36	33	
7		40	32	31	
8		36	40	40	
9		52	52	43	
10		58	71	55	
11		52	46	52	
12		51	44	45	

Other Information	Are the concentrations stated in ug/m^3?	Did the diffusion tube supply or analysis method change during the monitoring period? When, from what, to what?	Were there any significant problems with the continuous analyser during the monitoring period?	Are there any other relevant issues with your data?
	Yes	No	No	The coating of the diffusion tube "grid" is undertaken by South Yorkshire Laboratory

Please Return Completed Questionnaires to: denisewelch@aqconsultants.co.uk
This questionaire has been compiled and distributed by Air Quality Consultants Ltd on behalf of Defra and the DAs

Orthogonal Regression

2.1 The preferred method of combining long-term average collocation data to derive an overall bias adjustment factor relies on orthogonal regression. Most people are familiar with standard linear regression, whereby a best-fit line is added to a scatter of data. Standard linear regression assumes that all error is in the y axis, and that values on the x axis are known with certainty. Orthogonal regression differs from standard linear regression in that it takes account of uncertainty in both the x axis and the y axis. This is necessary because even though chemiluminesence analysers measure with more certainty than diffusion tubes, the value that they give is still not certain.

2.2 The method used was developed for Air Quality Consultants Ltd. specifically for this purpose by Prof. Gillian Raab of Napier University, Edinburgh. It allows the relative uncertainty associated with the different measurement methods to be accounted for and assumes that the diffusion tube results are twice as uncertain as the chemiluminesence analyser results. The regression line has been forced through zero, so as to give a single adjustment factor for each laboratory / tube combination.

2.3 If you wish to have your collocation data processed using this method, email nick.martin@npl.co.uk
.

2.4 For most purposes, a reasonable approximation of our method can be derived by averaging the bias values, expressed as a factor, i.e. -16% is -0.16. Next add 1 to this value, e.g. -0.16 + 1.00 = 0.84 in this example, then take the inverse to give the bias adjustment factor 1/0.84 = 1.19. (This will not be exactly the same as the correction factor calculated using orthogonal regression as used in this spreadsheet, but will be reasonably close). IT IS IMPORTANT NOT TO AVERAGE THE ADJUSTMENT FACTORS.