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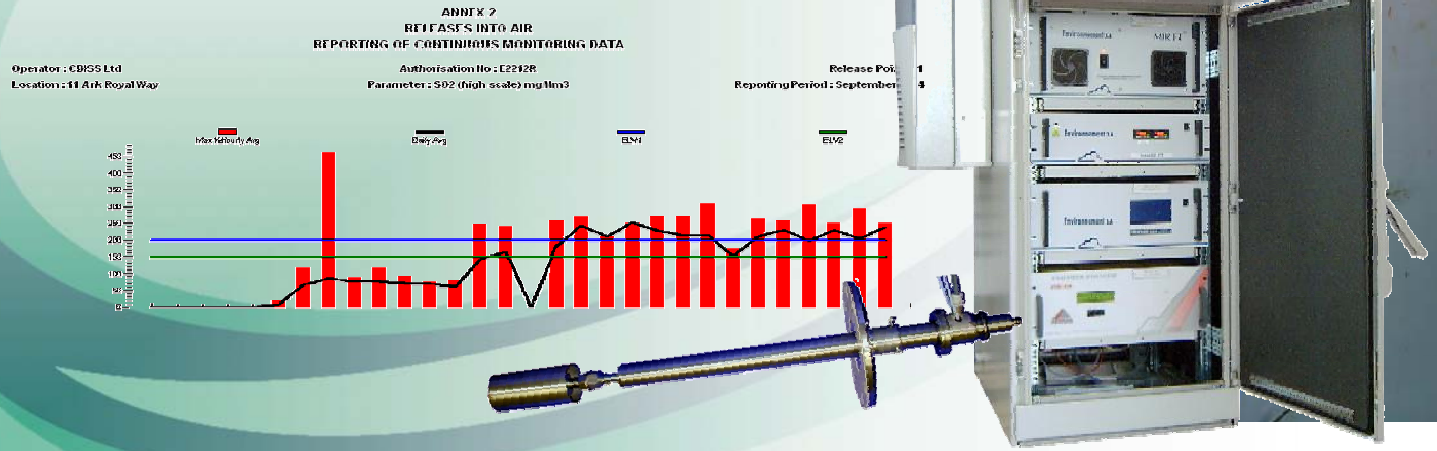
Practical Examples Of Installed Systems

Mark Davidson



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Who are CBISS?

- We are an ISO 9001 accredited engineering company based in the North West of England.
- We specialise in Emissions monitoring and gas analysis
- We employ over 50 people and have offices across the UK

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Why do we have CEMS ?

- Environmental - Green and clean !
- Process optimisation !
- **IN THE MAJORITY OF CASES ITS DUE TO LEGISLATION**
- Waste Incineration Directive (WID)
- Large Combustion Plant Directive (LCPD)
- IPPC/IPC

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What Techniques are available?

- In-Situ - Folded Beam
  - Cross Duct
- Extractive - Cold
  - Dilution
  - Hot/Wet (heated lines)
  - Drying system - Chillers
  - Permeation

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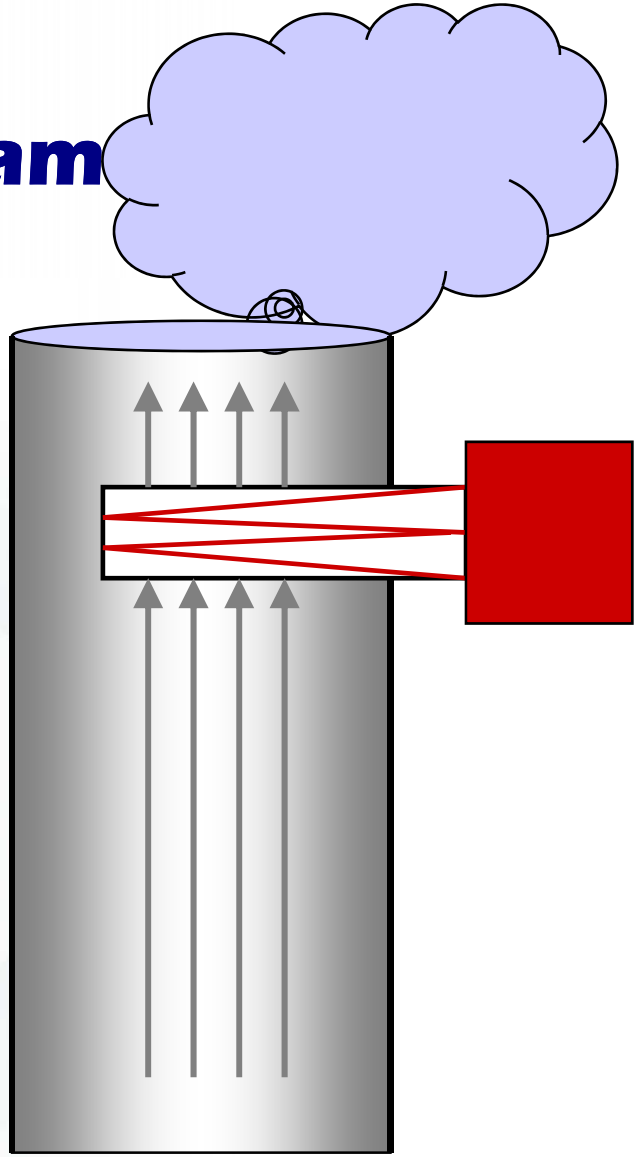
In-Situ Folded Beam

- Fits on Stack
- Gas diffuses into tube
- Analysis inside tube
- Cal gas injected inside tube
- Fast response time
- No conditioning required



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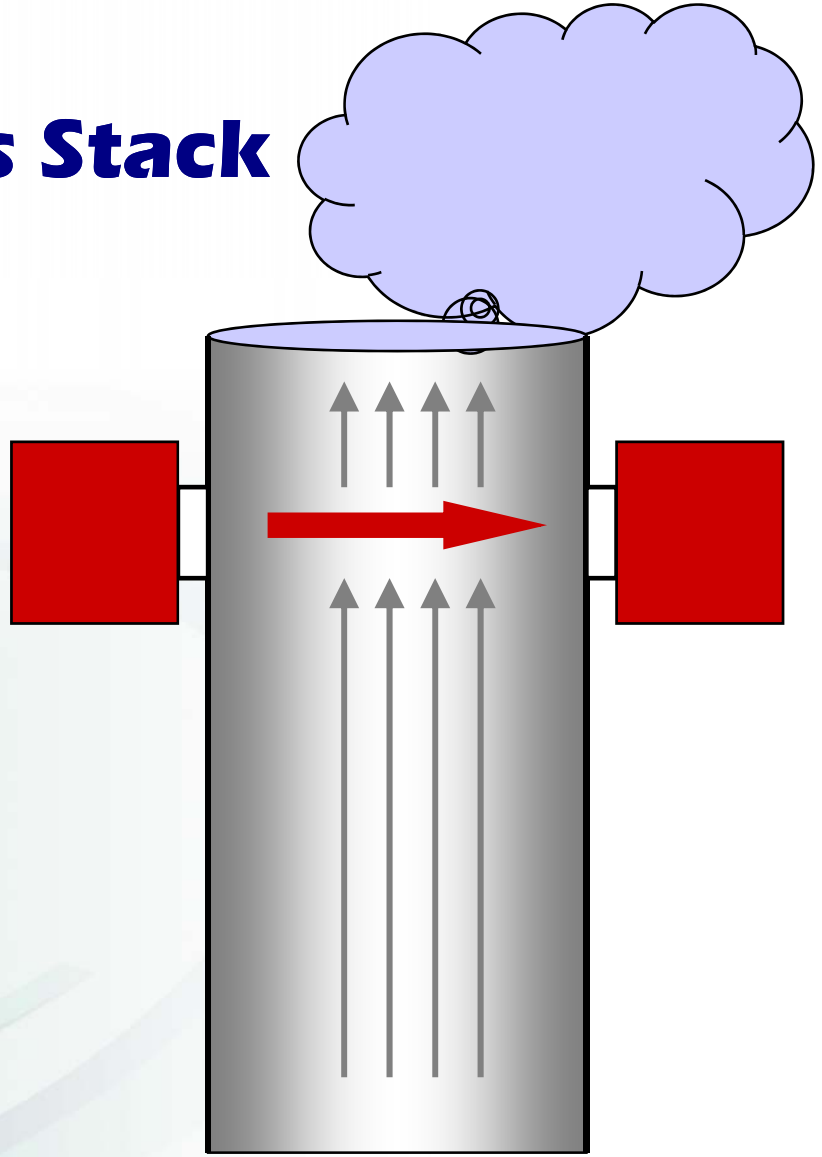
In-Situ Cross Stack

- Fits on Stack 2 flanges
- IR Beam across Stack
- No conditioning required
- Calibration electronically
- Fast response time



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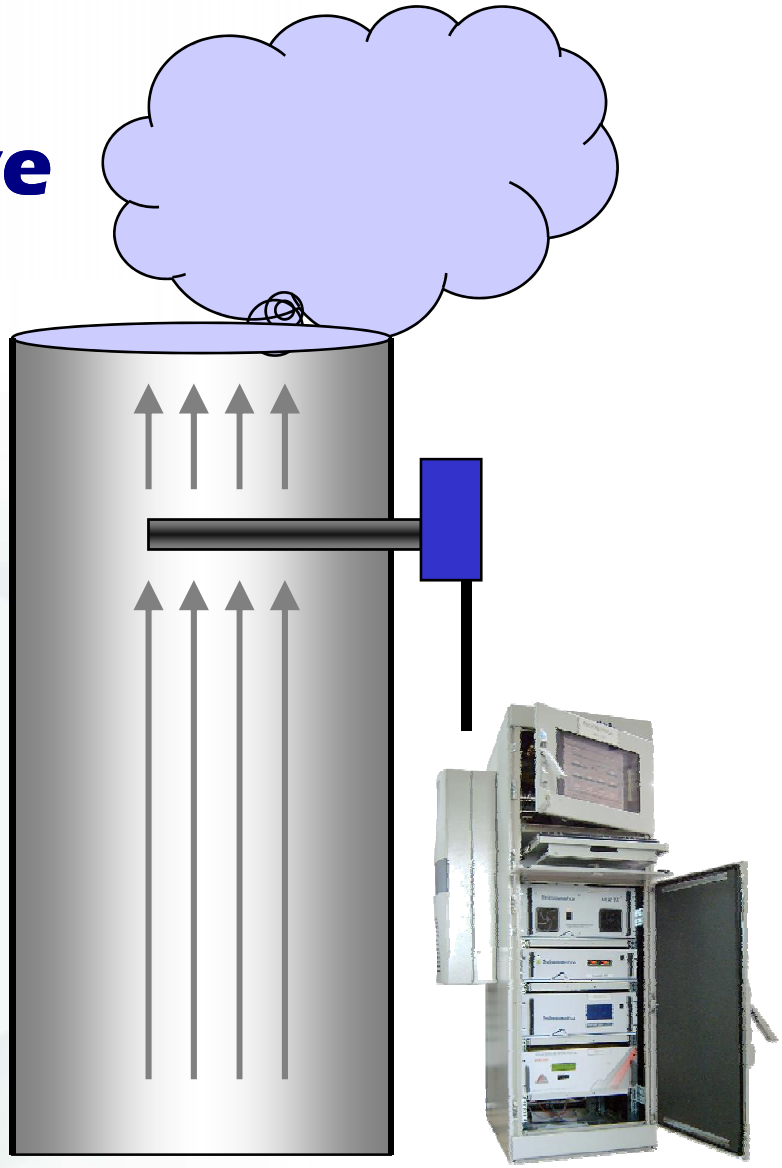
Extractive

- Sample gas is extracted from the stack and transported to the analyser for measurement.
- The major benefits are - The analyser can be proven by injection of zero and calibration gas (QAL3)
- Sensitivity is not related to stack diameter.
- Varying Stack temperatures do not effect optical alignment.

Extractive - Cold. This is the simplest and cheapest method but it can only be used with non-soluble gases and on ambient temperature processes/stacks.



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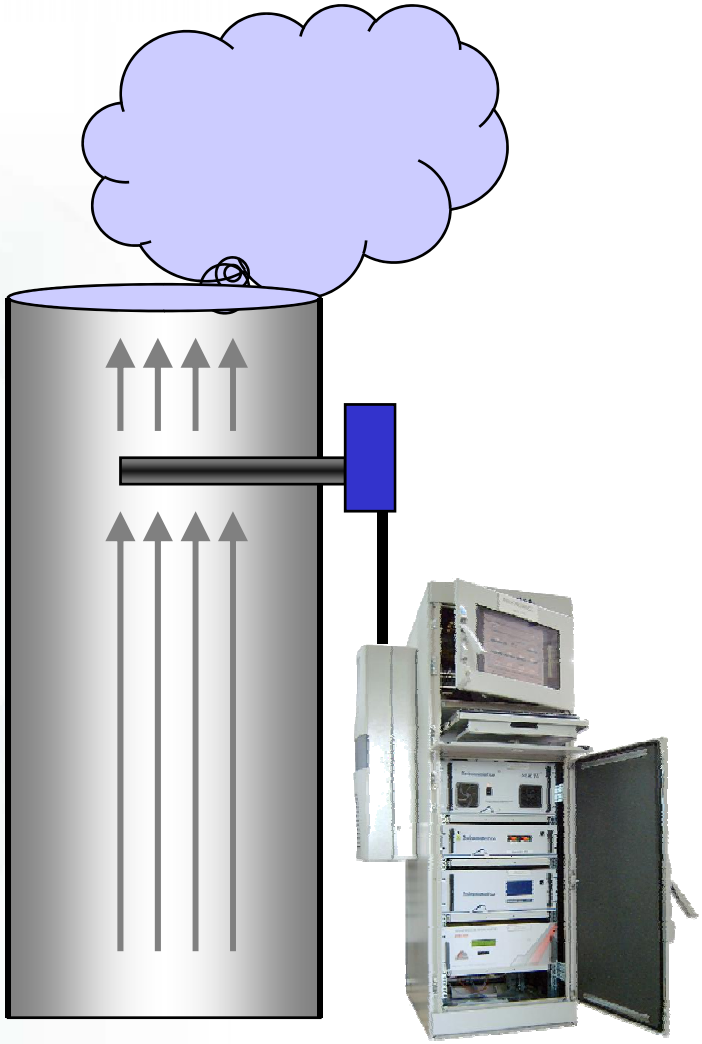
Extractive - Hot/Wet (Heated lines)

- Sample gas is extracted from the stack and transported to the analyser using heated line and heated sampling components- filters pumps etc, including the analyser measurement cell. The temperature of all components in contact with the sample gas is typically at 185^{o}c to avoid condensation and loss of soluble gases.
- The major benefits are - Can be used for the majority of gases.



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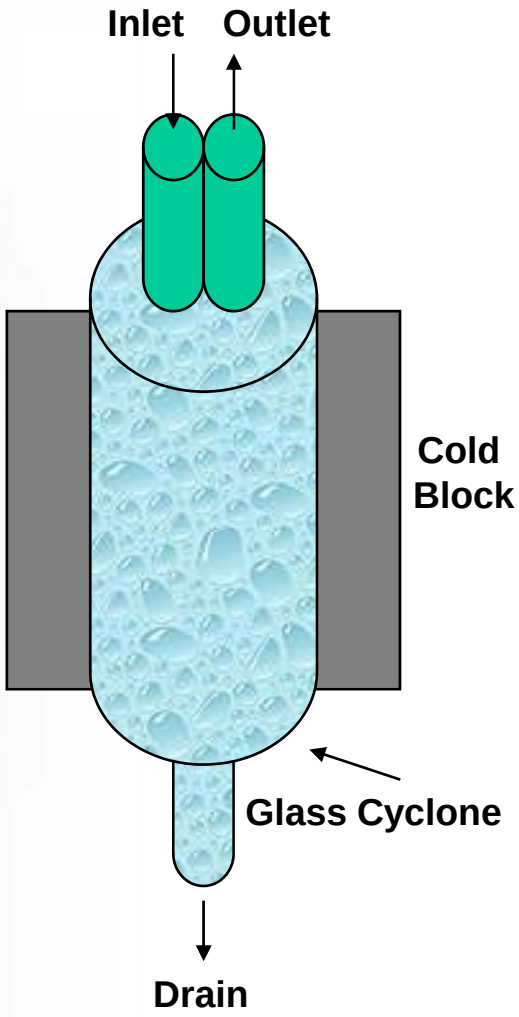
Extractive - DRY (Chillers)

- Sample gas is passed through a chiller to take the sample gas down to a low temperature and to remove water so sample is almost dry !.
- Advantages - Can use analysers operating at low/ambient temperatures so components are not heat stressed. Because analysers and sampling components are running at low temperatures, systems tend to be cheaper than heated systems.
- Disadvantages - Avoid using lower cost peltier coolers they may lose soluble gases needs to be below 4ºC. Cannot be used on very soluble/corrosive gases. Still require heated sampling components/heated line up to chiller to avoid condensation and loss of soluble gases.



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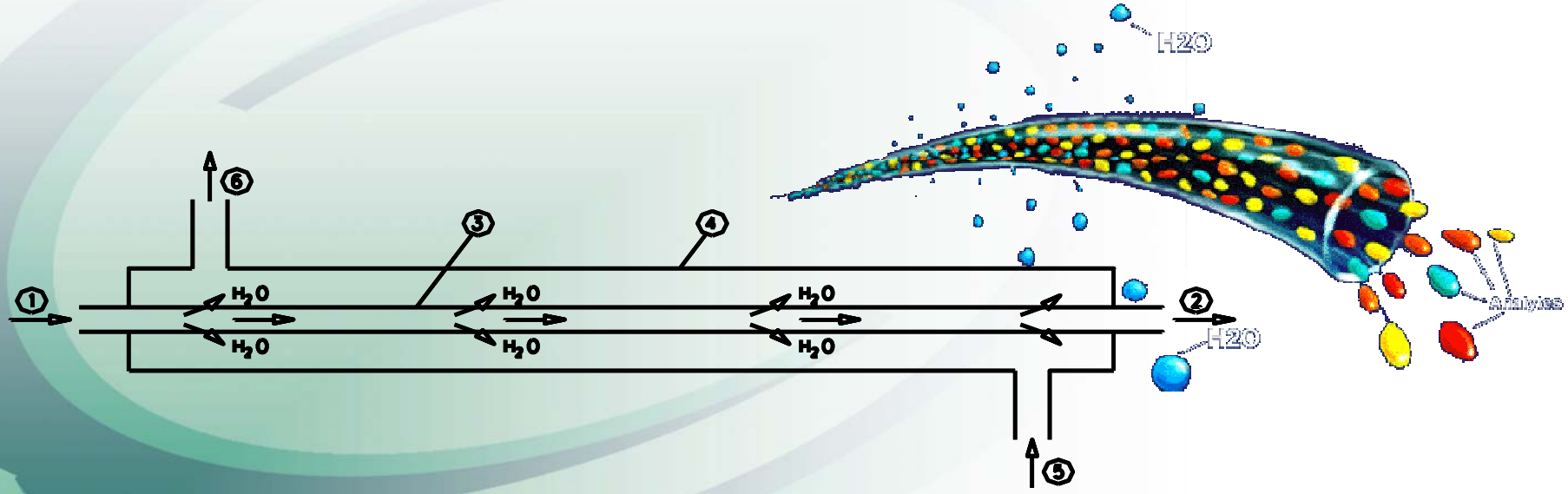
Extractive - DRY (Permeation)

- Sample is Dried at Stack (no heated line) Dry air only and low power
- Sample is dry,clean, low temp
- Sample is dry so no H_2O measure required or H_2O interference
- Stream switching and dual standby is easy



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Types of Extractive Analysers

- Electrochemical
- Single component analysers heated/non heated various methods IR, UV etc
- Multi- Gas heated typically IR or FT-IR
- Multi- Component GFC IR with dryer.

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On stack mounting

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Close coupled mounting

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MIR9000 Wall Mount

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MIR-FT Rack Mount

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Further Examples

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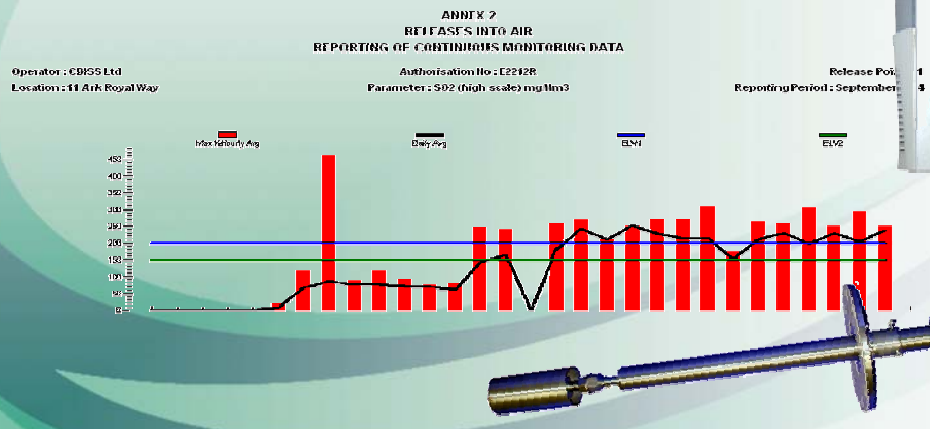
EN14181
What This Means To The Operator



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EN 14181 – The QAL's

Quality Assurance of Automated Measuring Systems

"***(QAL 1)*** *to demonstrate that the AMS is suitable for the intended purpose before installation, by meeting required performance standards and the uncertainty budgets specified in the EU directives;"*

"***(QAL 2)*** *to calibrate the AMS and determine the variability of the measured values obtained by it; so as to demonstrate the suitability of the AMS for its application, following installation;"*

"***(QAL 3)*** *to maintain and demonstrate the required quality of the measurement results during the normal operation of the AMS, by checking that the zero and span characteristics are consistent with those determined during QAL 1;*"

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EN 14181 – QAL 1

Quality Assurance of Automated Measuring Systems

"***(QAL 1)*** *to demonstrate that the AMS is suitable for the intended purpose before installation, by meeting required performance standards and the uncertainty budgets specified in the EU directives;"*

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EN 14181 – QAL 1

SUMMARY REPORT - Waste Incineration

Expanded Uncertainties of ENVIRONNEMENT SA's AMS : MIR 9000, MIR FT and GRAPHITE 52M

Environnement s.a

AMS	Gas	Expanded uncertainty at 95% (in mg/m3 dry without O2 correction)	Expanded uncertainty at 95% (in mg/m3 dry corrected @11%O2)	Expanded uncertainty at 95% (in % of ELV dry corrected @11%O2)	Maximum Authorized Expanded Uncertainty according to Directive 2000/76/CE	AMS acceptable (Yes/No)
MIR 9000	HCl	3,38	3,40	34,0%	40,0%	Yes
MIR 9000	SO2	6,73	6,07	13,5%	20,0%	Yes
MIR 9000	NO	7,49	10,48	3,7%	20,0%	Yes
MIR 9000	NOx	7,89	11,03	3,9%	20,0%	Yes
MIR 9000	CO	2,83	3,37	5,7%	10,0%	Yes
MIR 9000	TOC	under evaluation	under evaluation	under evaluation	30,0%	-
GRAPHITE 52M (used with MIR 9000)	TOC	0,83	0,91	9,1%	30,0%	Yes
MIR FT	HCl	0,74	0,84	8,4%	40,0%	Yes
MIR FT	SO2	2,79	3,40	6,8%	20,0%	Yes
MIR FT	NO	11,82	16,74	5,6%	20,0%	Yes
MIR FT	NOx	12,44	17,62	5,8%	20,0%	Yes
MIR FT	CO	2,51	3,17	6,3%	10,0%	Yes
MIR FT	TOC	0,83	1,00	10,0%	30,0%	Yes
GRAPHITE 52M (used with MIR FT)	TOC	0,86	0,94	9,4%	30,0%	Yes

Nota :
1) NO & NOx expressed as mg/m3 eq NO2. TOC expressed as mgC/m3
2) Data from TÜV reports for MIR FT and GRAPHITE 52M are on a dry basis
3) Data from MCERT report MIR 9000 and MIR 9000 O2 sensor are on dry basis
4) Data for MIR FT O2 sensor are on wet basis

Calculations according to EN ISO 14956 Standard - Summary - v8, December 8th, 2004 - DM/SA

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EN 14181 – QAL 1

Expanded Uncertainty of MIR 9000 AMS for use in Waste Incineration in the EU
Gas : HCl

MIR 9000

Environnement S.A

Certification Range (CR) : 98,4 mg/m3 (MCERT / 60 ppm)
Test concentration (TC) : 82,0 mg/m3 (MCERT / 50 ppm)
Emission limit value (ELV) : 10,0 mg/m3 corrected to dry @11%vO2 (daily)

Partial uncertainty	Result of MCERT test			u (HCl) (mg/m3)	u^2 (HCl)	Remarks
Refer to "Formula" sheet. Equation n° x	% of CR or TC	mg/m3 referred to CR or TC	mg/m3 referred to ELV			
n°1 - Uncertainty due to linearity (lack of fit) : u_{lin}	0,710%	0,699	-	0,403	0,1627	MCERT Laboratory Evaluation Report page 18-Table 6a
n°2 - Uncertainty due to zero drift : u_{inst}(zero drift)	-	-	-	-	-	Zero drift < Span drift : not considered
n°3 - Uncertainty due to span drift : u_{inst}(span drift)	1,700%	1,394	0,170	0,098	0,0096	MCERT Field Evaluation Report - Page 27 (% TC / week)
n°4 - Uncertainty relating from variations in ambient pressure expressed as standard deviation : u_{press}	N.A.	N.A.	N.A.	0,000	0,0000	N.A. , no sensitivity to atmospheric pressure variations (compensation)
n°5 - Uncertainty relating from variations in ambient temperature expressed as standard deviation : u_{temp}	2,388%	2,331	-	1,348	1,8105	MCERT Laboratory Evaluation Report page 30-Table 10a (interpolation at 20°C +/-5°C)
n°6 - Uncertainty due to cross interferences : u_{inst}(int)	-	-1,582	-	-0,913	0,8343	MCERT Laboratory Evaluation Report page 22-Table 7a. Max (Σ interferences +,Σ interferences -)
n°7 - Standard deviation of repeatability at zero : Sr,o	0,045%	0,045	-	0,026	0,0007	MCERT Laboratory Evaluation Report page 26-Table 8a. Sr,o < Sr,s : not considered
n°8 - Standard deviation of repeatability at test concentration : $S_{r,s}$	0,177%	0,175	-	0,175	0,0305	p 27 tab 9a repeatability divided by t student (2,65)
n°9 - Uncertainty due to span gas unaccuracy : u_{sg}	-	2,000%	0,20	0,115	0,0133	span gas relative accuracy : 2%
n°10 - Uncertainty relating from correction to dry : u_{condry}	N.A.	N.A.	N.A.	N.A.	N.A.	Measurements are made on a dry sample thanks to SEC sampling device (permeation-based)
					2,8610	Sum of u^2 (HCl), without O2 correction
n°11 - Uncertainty relating from influence of correction to O2 : u_{inO2}					0,0335	Refer to "O2" uncertainty calculation sheet
					2,8945	Sum of u^2 (HCl), with O2 correction

Combined uncertainty u_c (HCl) :	1,691 mg/m3 (dry without O2 correction)	$\sqrt{\sum u^2(HCl)}$
Combined uncertainty u_c (HCl) :	1,701 mg/m3 (dry with O2 correction)	
Expanded uncertainty U (HCl) at 95% confidence interval (K=2) :	**3,38 mg /m3 (dry without O2 correction)**	
Expanded uncertainty U (HCl) at 95% confidence interval (K=2) :	**3,40 mg /m3 (dry at 11%O2)**	
Expanded uncertainty U (HCl) at 95% confidence interval (K=2) :	**34,0% of ELV (dry @11%O2)**	
Required U_{req}(HCl) according to 2000/76/CE Directive :	**40,0% of ELV (dry @11%O2)**	
U (HCl) <U_{req}(HCl) - MIR 9000 for HCl complies with Waste Incineration Directive 2000/76/CE		

Calculations made according to EN ISO 14956 Standard - MIR HCl data - v8, December 9th, 2004 – DM/SA

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EN 14181 – QAL 2

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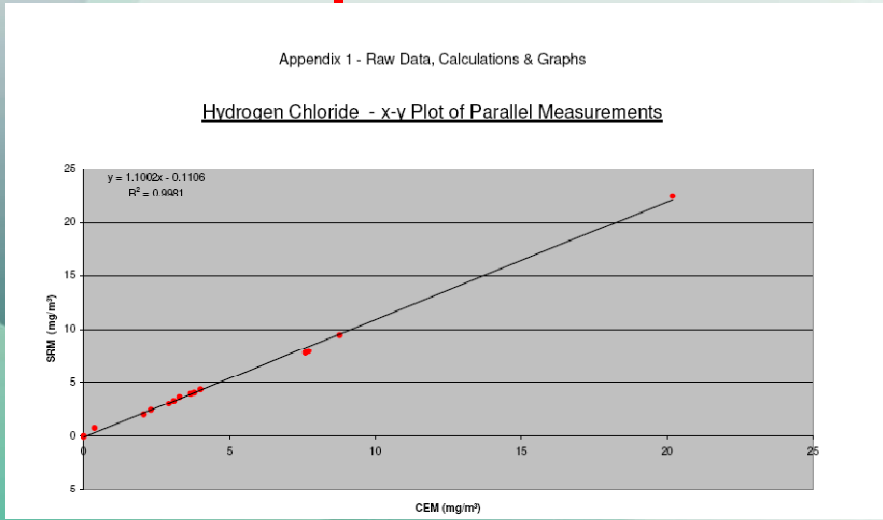
EN 14181 – QAL 2



- Instrument Compared to Standard Reference Method (SRM) in a Parallel Test.
- Results From Two Instruments Compared and Linear Calibration Function Generated
- All Data from the AMS is now Calibrated in Software Against This Function.
- Range of Data used to Generate Function Provides Valid Instrument Range. Emissions Should Remain Within This Range or New QAL 2 Performed.

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QAL 2 Report

- Once the tests have taken place and the successful report has been issued, the data is utilised by the software package
- The AMS must be calibrated to the SRM results
- Various software packages are available with an additional upgrade specifically for the EN14181 standard

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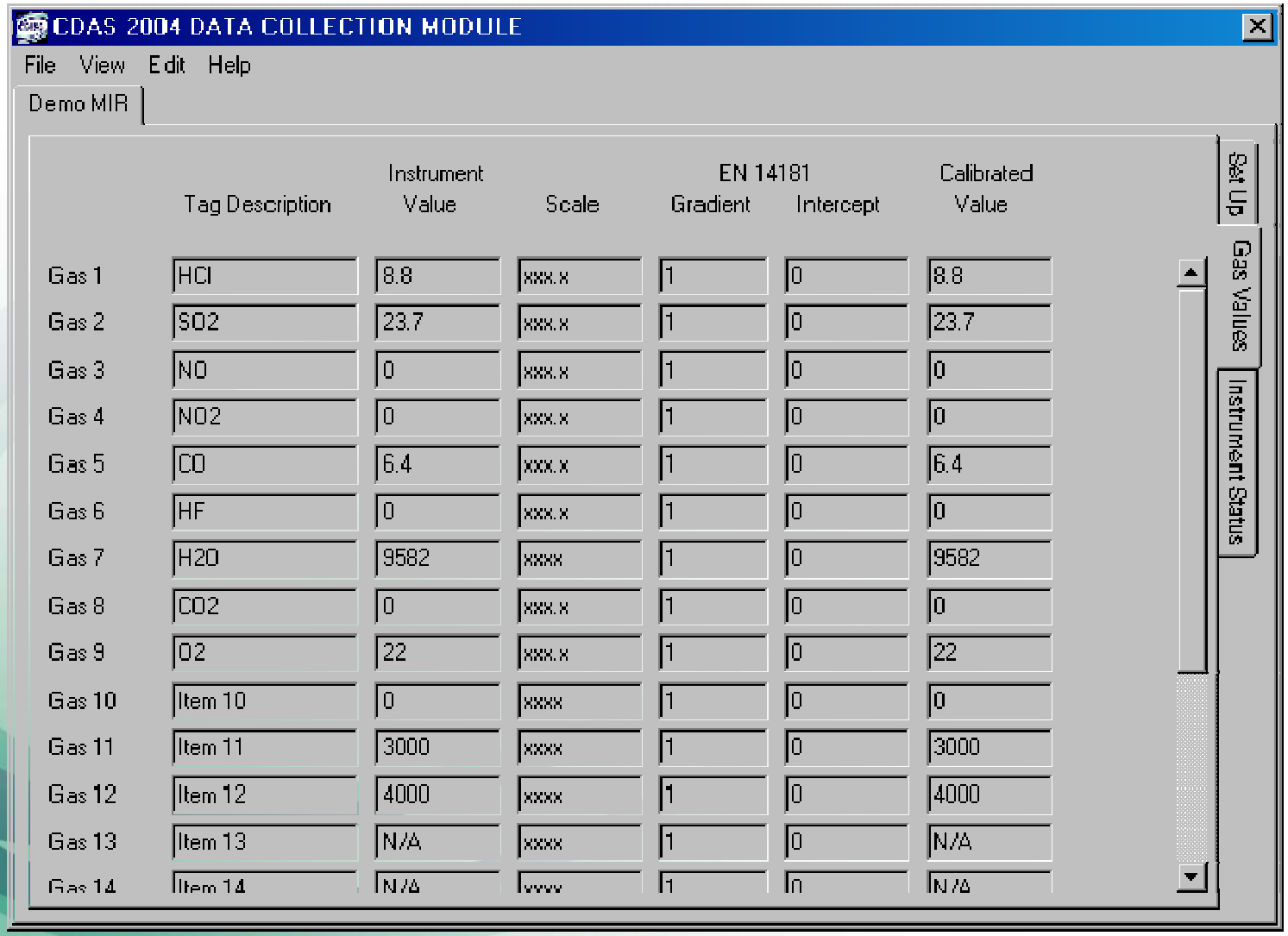
Example QAL 2 software



	Tag Description	Instrument Value	Scale	EN 14181 Gradient	EN 14181 Intercept	Calibrated Value
Gas 1	HCl	8.8	xxx.x	1	0	8.8
Gas 2	SO2	23.7	xxx.x	1	0	23.7
Gas 3	NO	0	xxx.x	1	0	0
Gas 4	NO2	0	xxx.x	1	0	0
Gas 5	CO	6.4	xxx.x	1	0	6.4
Gas 6	HF	0	xxx.x	1	0	0
Gas 7	H2O	9582	xxxx	1	0	9582
Gas 8	CO2	0	xxx.x	1	0	0
Gas 9	O2	22	xxx.x	1	0	22
Gas 10	Item 10	0	xxxx	1	0	0
Gas 11	Item 11	3000	xxxx	1	0	3000
Gas 12	Item 12	4000	xxxx	1	0	4000
Gas 13	Item 13	N/A	xxxx	1	0	N/A
Gas 14	Item 14	N/A	xxxx	1	0	N/A

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EN 14181 – QAL 3

Quality Assurance of Automated Measuring Systems

"***(QAL 3)*** *to maintain and demonstrate the required quality of the measurement results during the normal operation of the AMS, by checking that the zero and span characteristics are consistent with those determined during QAL 1;*"

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EN 14181 – QAL 3

- Regular zero and span check to ensure equipment continues to meet the uncertainty specification.
- Results of these measurements need to be recorded.
- Analysis of the all recent recorded results must be performed.
- If necessary actions must be taken if results of analysis show problems with performance of the monitoring system.

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EN14181 - Analysis of Results

- EN 14181 QAL 3 allows for two methods of analysing results.
    - Shewhart Chart
    - CUSUM
- A report will be generated upon completion of the QAL 3 calibration and any problems arising should be clearly noted on the report.
- Possible to recreate old reports as well as viewing results of the calibration.

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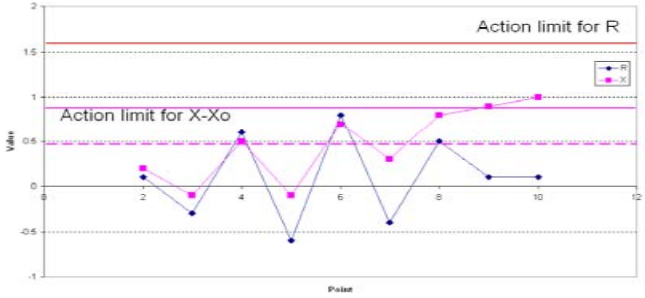
EN 14181 – QAL 3

Weekly QAL 3 Report
Gosford Incinerator
CUSUM Chart for CO : Analyser MIR9000
Report Generated 10th January 2005
Report for Data from 2/9/04 to 5/1/05



Summary of Analysis

S_{ams} = 0.789

Drift

S_t > 2.850 S_{ams} : 2.850 > 2.249 **OK**
S_t > 0.501 S_{ams} : 0.254 > 0.395 **OK**

Precision

S_t > 6.900 S_{ams} : 3.900 > 5.444 **OK**
S_t > 1.850 S_{ams} : 1.150 > 1.460 **OK**

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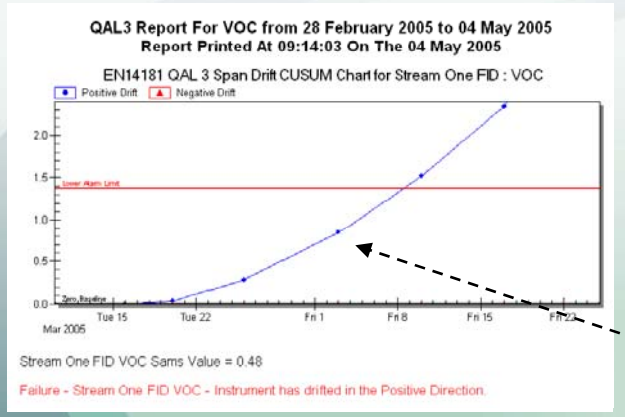
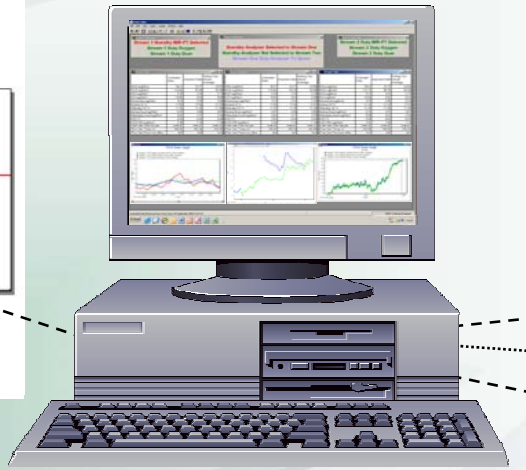
EN 14181 – QAL 3

- When a QAL 2 is completed the AMS should be QAL 3 “ready”.
- Analysers need to carry out calibration checks against span gas and zero readings at regular intervals.
- Results of these measurements need to be recorded.
- Analysis of all recently recorded results must be performed.



QAL 3 REPORTS
Cusum or Shewhart



Data logging & Control of Gas injection

IR analyser

Cal Gas BOX

FID Analyser

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EN 14181 – AST

- **AST - Annual Surveillance Test** used to ensure QAL 2 calibration function is maintained. Consists of alignment/cleaning of sampling system, leak test, zero/span, linearity, response time, interference check **plus 5 parallel measurements** spread evenly over one day, checking documentation and records followed by issuing of a report

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Summary

- Find out all of your stack conditions - temp, moisture, flow, particulate….
- Select the best technique for your environment – In-situ, Extractive….
- Compliant with relevant standards – WID, LCPD, MCERTS…
- Select a company who have the backup for all integrated products
- Select a software package which is flexible
- Turnkey contract from design to commissioning
- Remote diagnostics if possible
- Duplex systems - Justifiable?