TECNOLOGIAS MODERNAS PARA MEDIÇÃO CONTINUA DE EMISSÕES

Aplicação em Coprocessamento na Indústria de Cimento – São Paulo 29 de novembro de 2012

CARLOS ALBERTO TUMANG

SISTEMAS DE MEDIÇÃO DE EMISSÕES:

MC1000 Comercial Ltda.

MC 1000 COMERCIAL LTDA.

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All Cement Plants

Vigier Ciment Péry

JCF Wildegg

JCF Cornaux

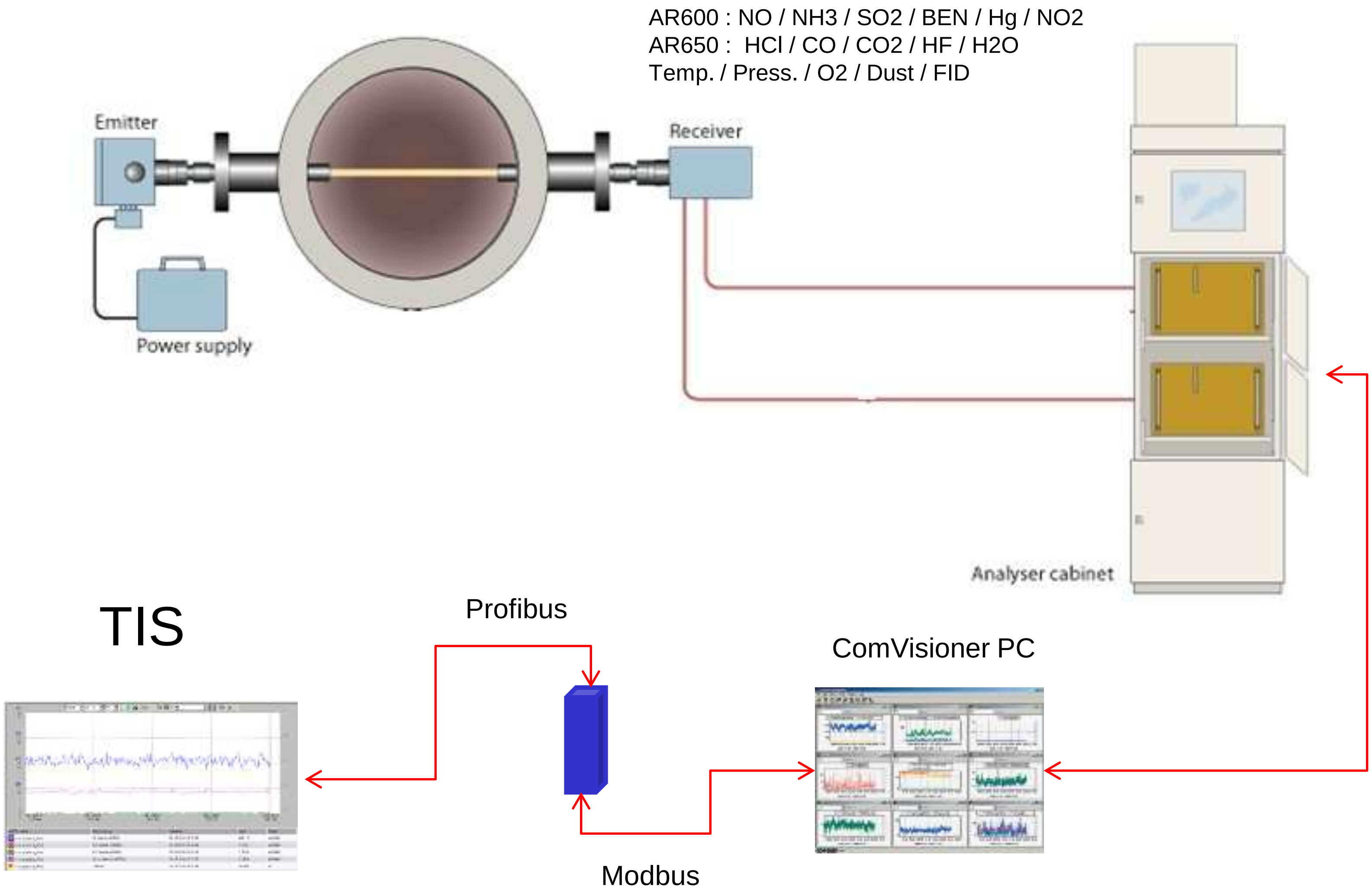
Holcim Siggenthal

Holcim Eclépens

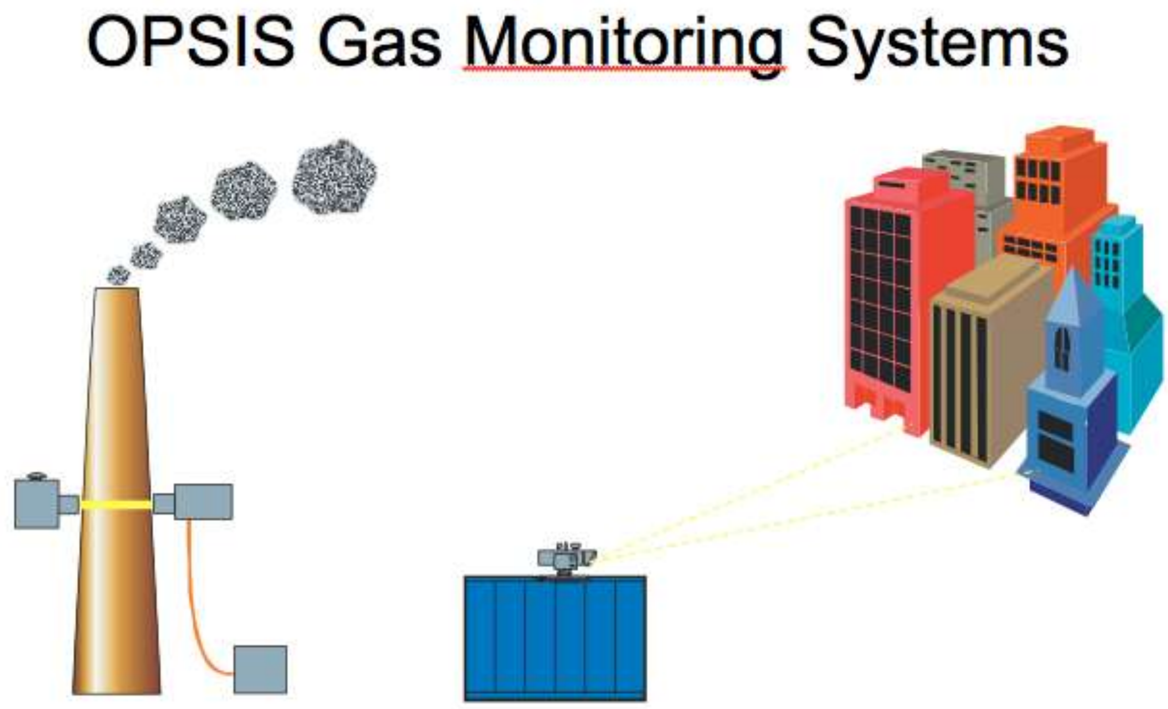
Holcim Untervaz

All Cement Plants are equiped with OPSIS

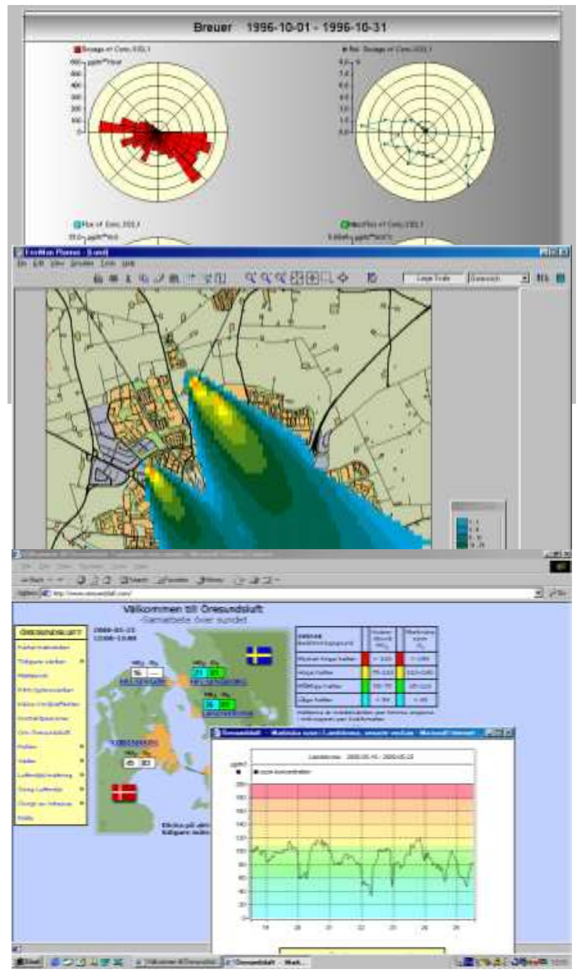
OPSIS®


AR600 : NO / NH3 / SO2 / BEN / Hg / NO2
AR650 : HCl / CO / CO2 / HF / H2O
Temp. / Press. / O2 / Dust / FID
Emitter
Receiver
Power supply
Analyser cabinet
TIS
Profibus
ComVisioner PC
Modbus

MONITORAMENTO DA POLUIÇÃO ATMOSFÉRICA
-FONTES DE EMISSÕES-QUALIDADE DO AR



MONITORAMENTO DA POLUIÇÃO ATMOSFÉRICA



METODOS E TECNICAS

Metodos de Amostragem

- In Situ - Sem coleta de amostra
    - No local – termopar
    - Feixe luz “Cross Stack”
    - Open path (Wikipedia)
- Amostragem extrativa
    - Wet-hot extractive
    - Dry extractive

Técnicas Analíticas

- DOAS
- FTIR
- IR absorption
- UV absorption
- Chemiluminescense
- UV-fluorescense
- TDL

- Etc....

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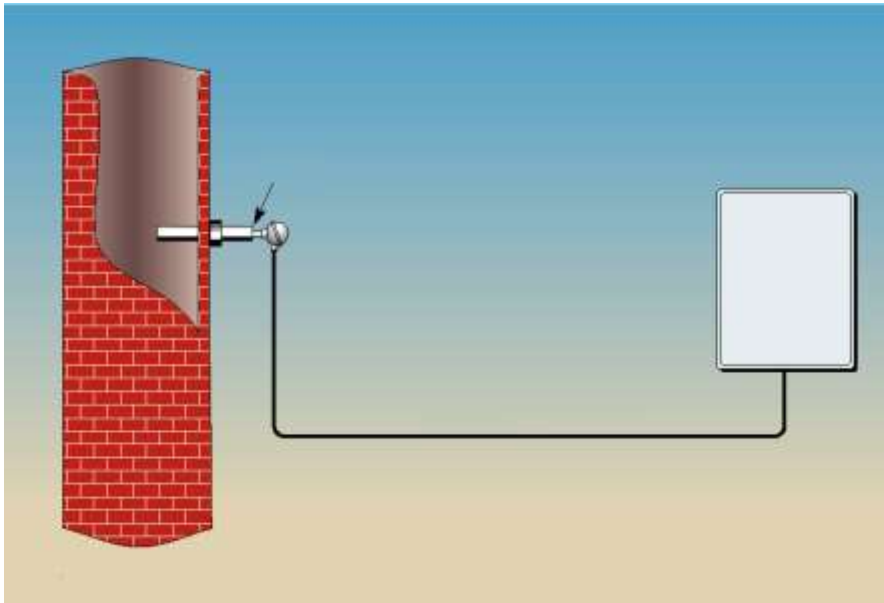
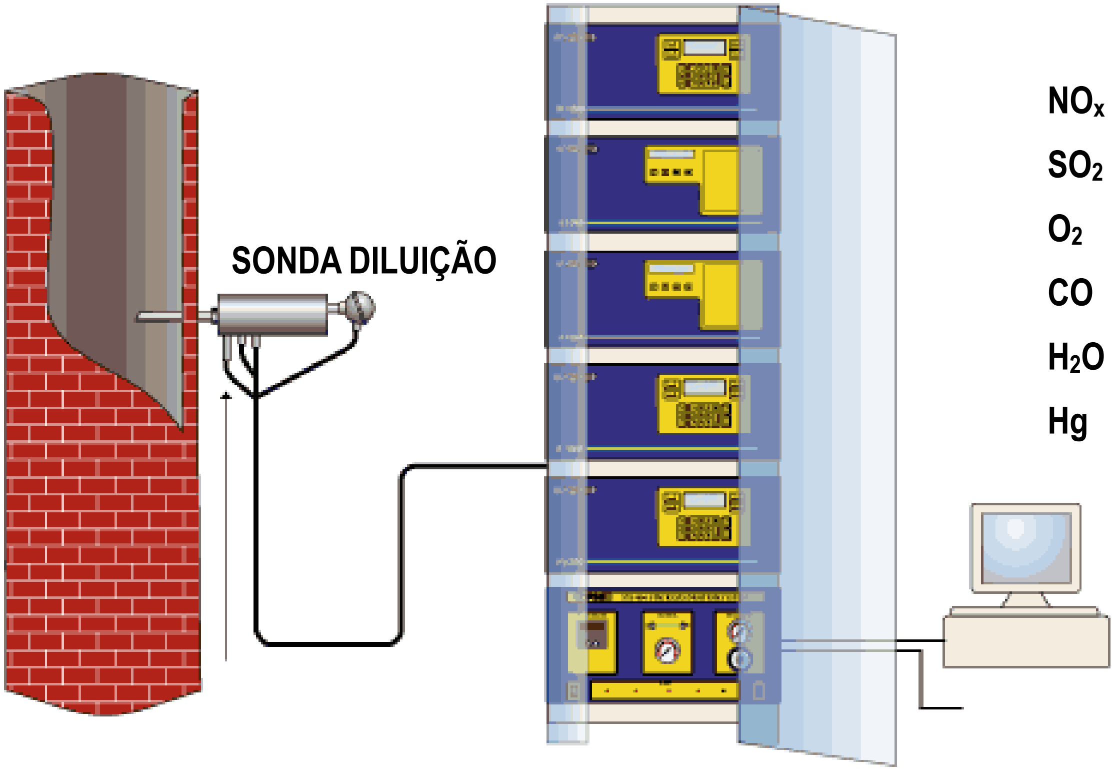
SISTEMAS EXTRATIVOS



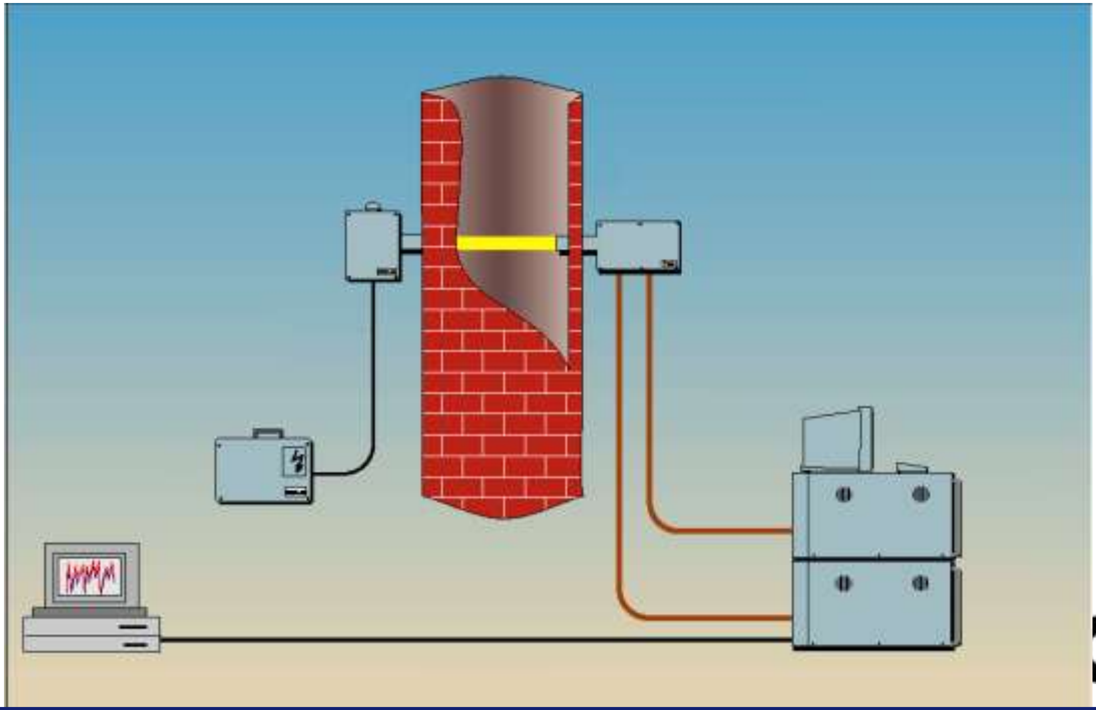
- Extração de Amostra
- Transporte de Amostra até Instrumentos
- Condicionar a amostra para sua análise
- Analisadores

SISTEMAS EXTRATIVOS: DILUIÇÃO



SISTEMAS NÃO-EXTRATIVOS

- NÃO HÁ EXTRAÇÃO: Os gases não tem contato e não atacam os sensores



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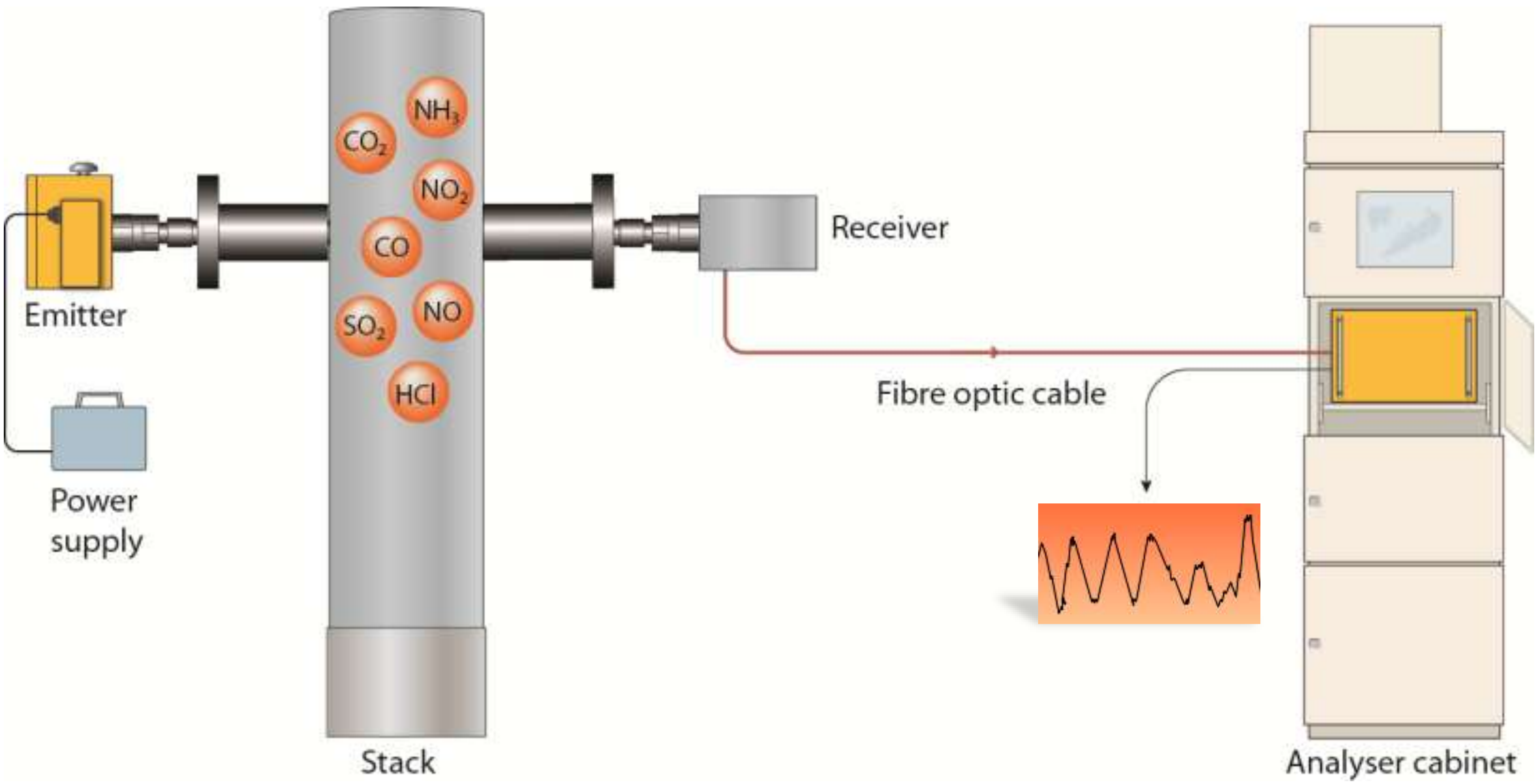
TECNOLOGIA OPSIS DOAS



Differential **O**ptical **A**bsorption **S**pectroscopy

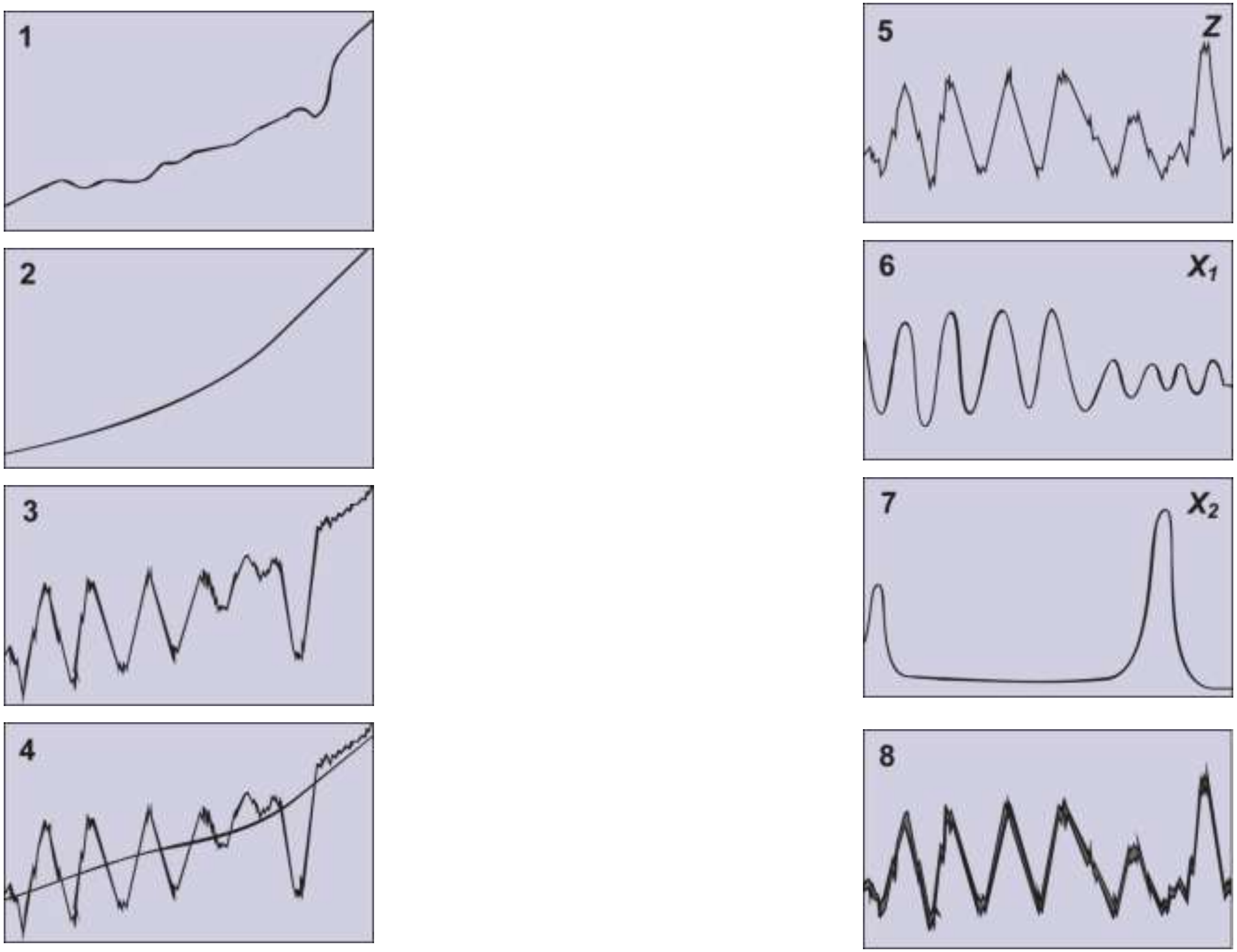
SISTEMAS NÃO-EXTRATIVOS: DOAS.

VANTAGENS:

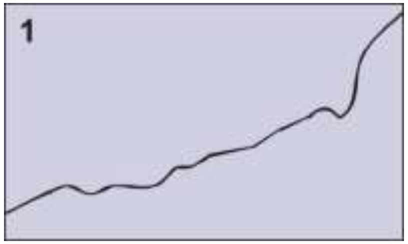
- Podem medir com precisão SO_2, NO_2, NO_3, NO, SO_3, Hg^+, NH_3, Benzeno, CH_4, CO, CO_2, Phenol, Formaldeído, HF, HCl, etc.
- Homologados e certificados por: TÜV, EPA, SIREP, NPL, INERIS, EUROPEAN RESEARCH CENTRE, CNR. Etc.
- Únicos multiparamétricos certificados por TÜV para todos os gases, incluidos HF.

OPSIS

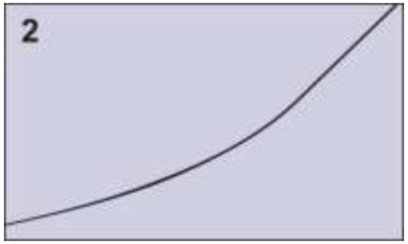
What Happens in the Computer?



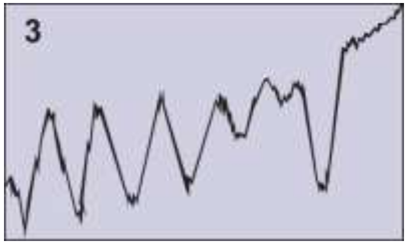
What Happens in the Computer?



1. Once the data has been collected, the raw spectrum is stored in the computer’s memory.



2. First the raw spectrum is compared with a zero-gas spectrum. This has previously been registered with no absorption gases present and is used as a system reference.



3. After division by the zero-gas spectrum, the total light absorption between the transmitter and the receiver is obtained. This result is caused not just by the gases that are present but also by e.g. dust in the atmosphere or dirty optics. The task now is to separate the light absorption of the gases from other influence.

4. To do this, the system takes advantage of the fact that only gas molecules will cause rapid variations in the absorption spectrum. The slow variations, which give rise to the gradient on the absorption curve, result from a large number of known and unknown factors. Their influence can be eliminated completely by matematically matching a curve which does not follow the rapid variations in the spectrum.

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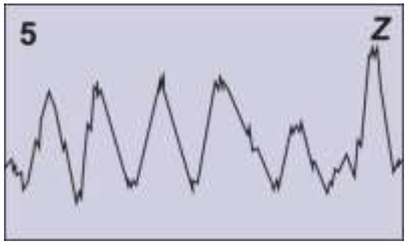
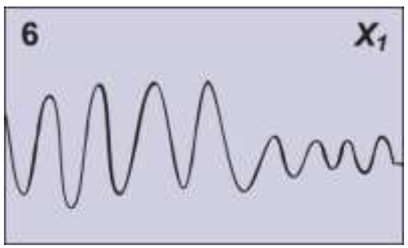
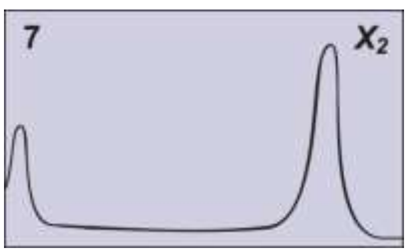
What Happens…cont'd



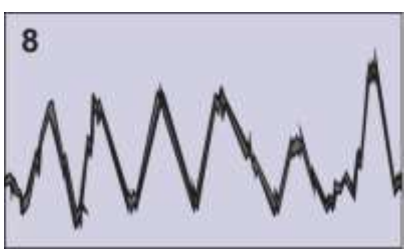
5. After a new division, all that remains are the rapid variations. For the remaining calculations, the logarithm of the curve is taken, which turns the curve upside down. A differential absorption spectrum has now been obtained. This spectrum is a combination of the various gases present between the transmitter and the receiver at the moment of detection. In the example this is called Z.



6-7. The gases that absorb light in this wavelength range are already known, and a pre-recorded reference spectrum for each gas is stored in the computer's memory. In this example there are only two gases, called X and X. The task is to determine the proportions of X and X that combine to give the best match for Z. The system achieves this by very rapidly creating a new curve out of the sum of the two reference spectra, varying values until the best correspondence is achieved.

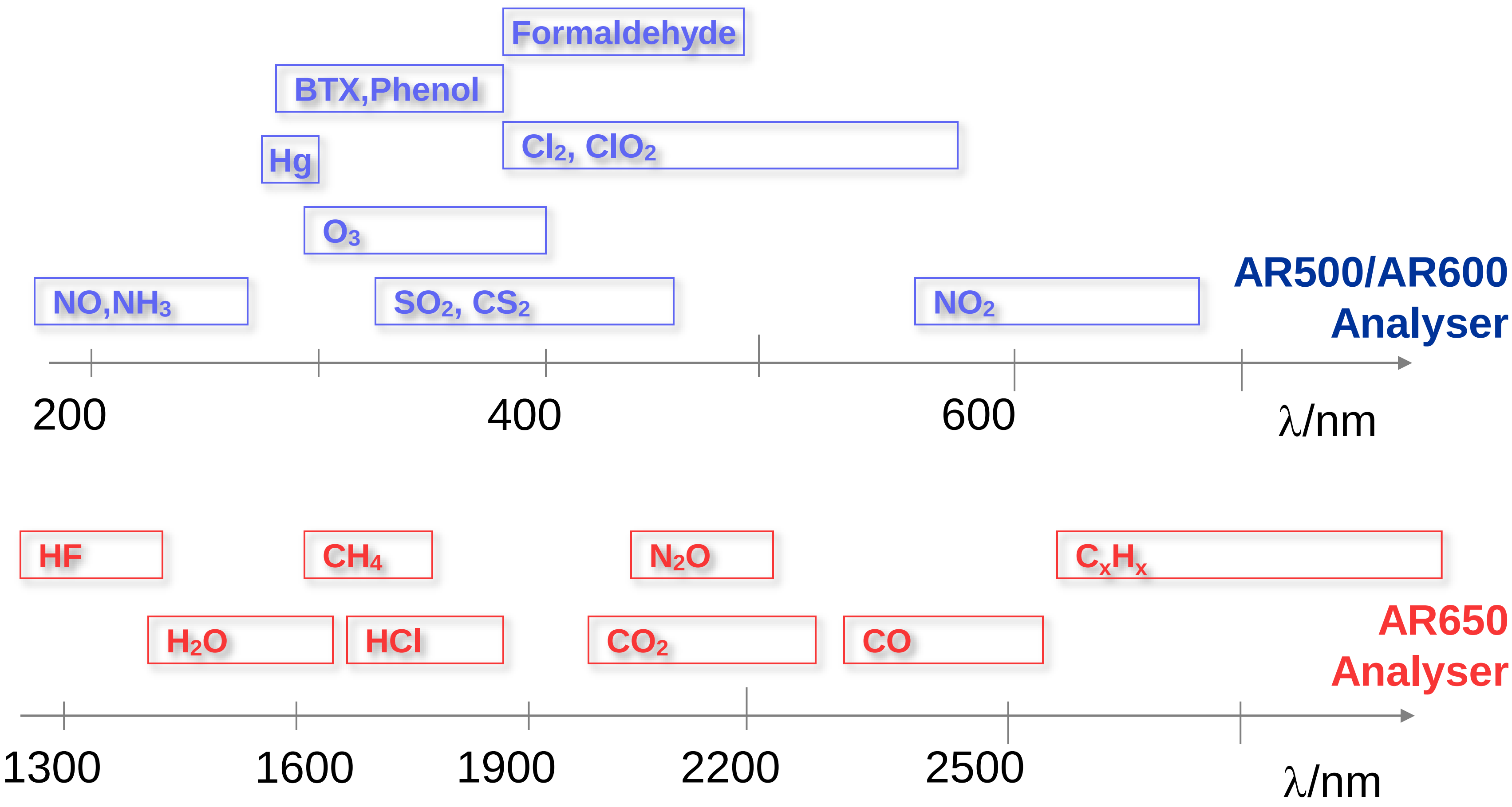


The equation the computer uses can be expressed as CX + CX = Z, where C and C are the proportions of each gas. From C and C it is then possible to calculate the current concentrations.

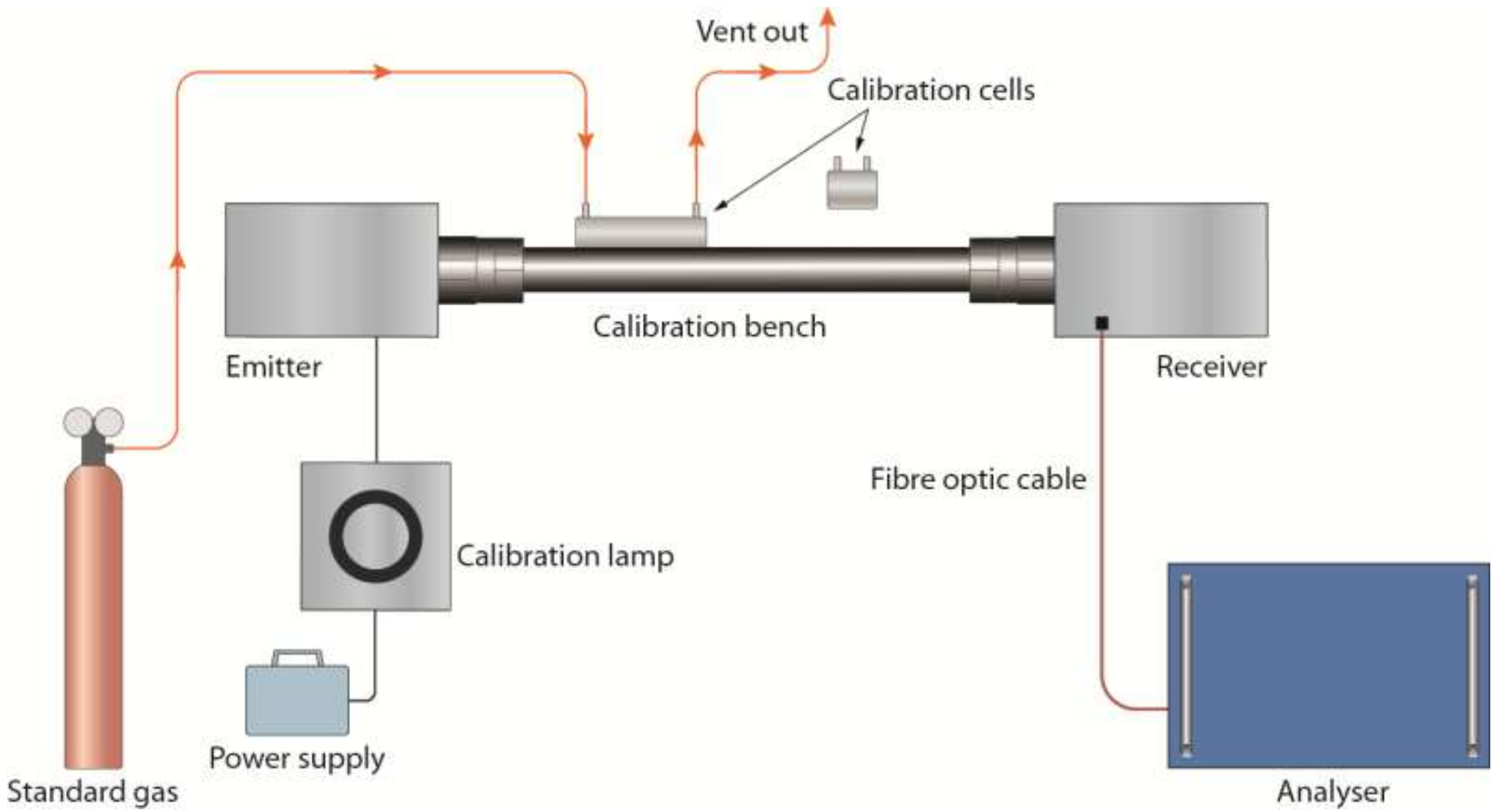


8. Finally, the result is checked by determining the difference between the measured and the calculated curves (the shaded area). Every measurement result can be stated with a standard deviation. The more reference curves stored in the computer's memory, the more accurate the result of the calculation will be. Even if there should be some unknown interference, the computer evaluates the gases it is programmed for.

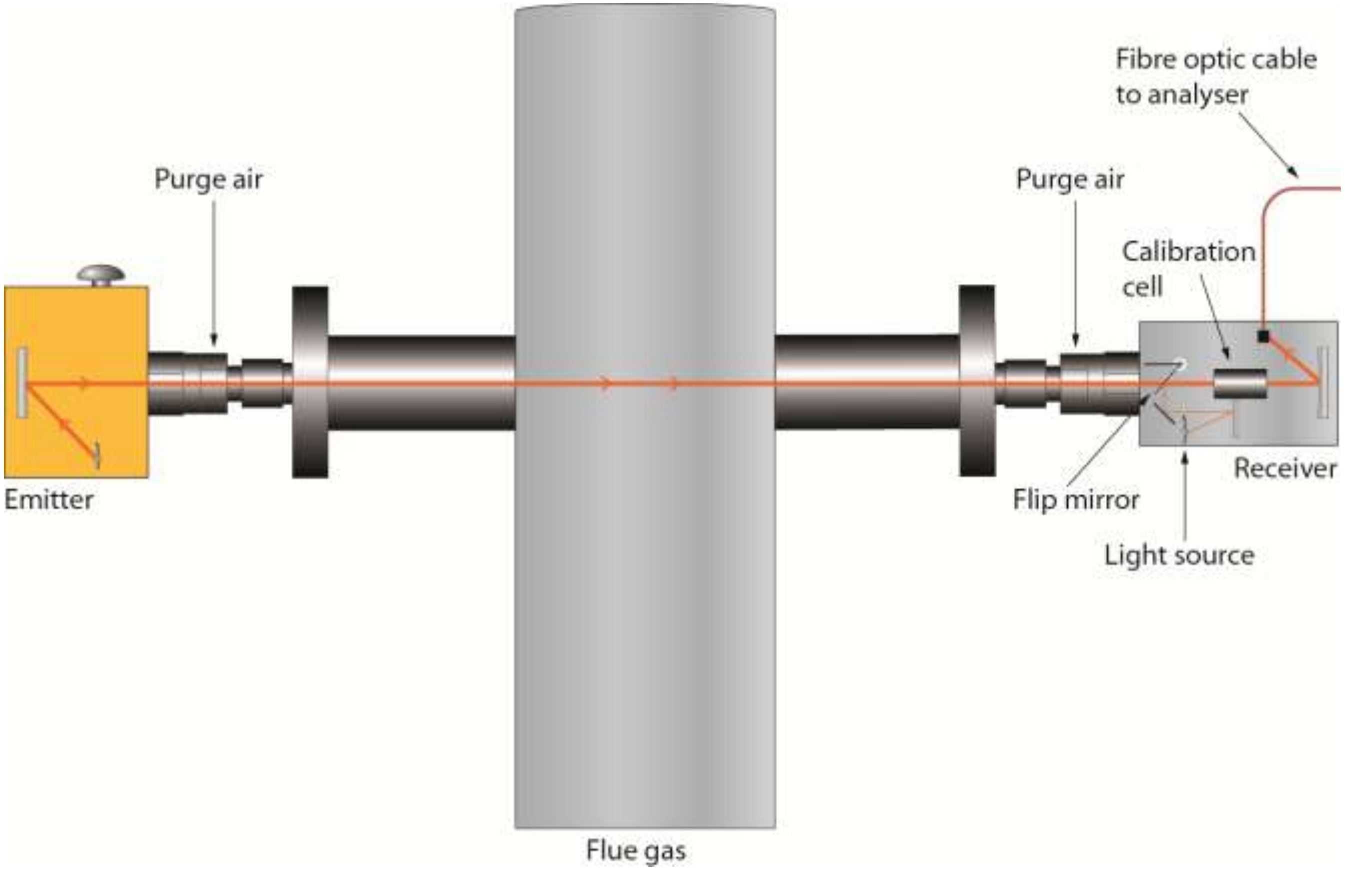
Typical Wavelength Intervals



Span and Zero Calibration – AQM

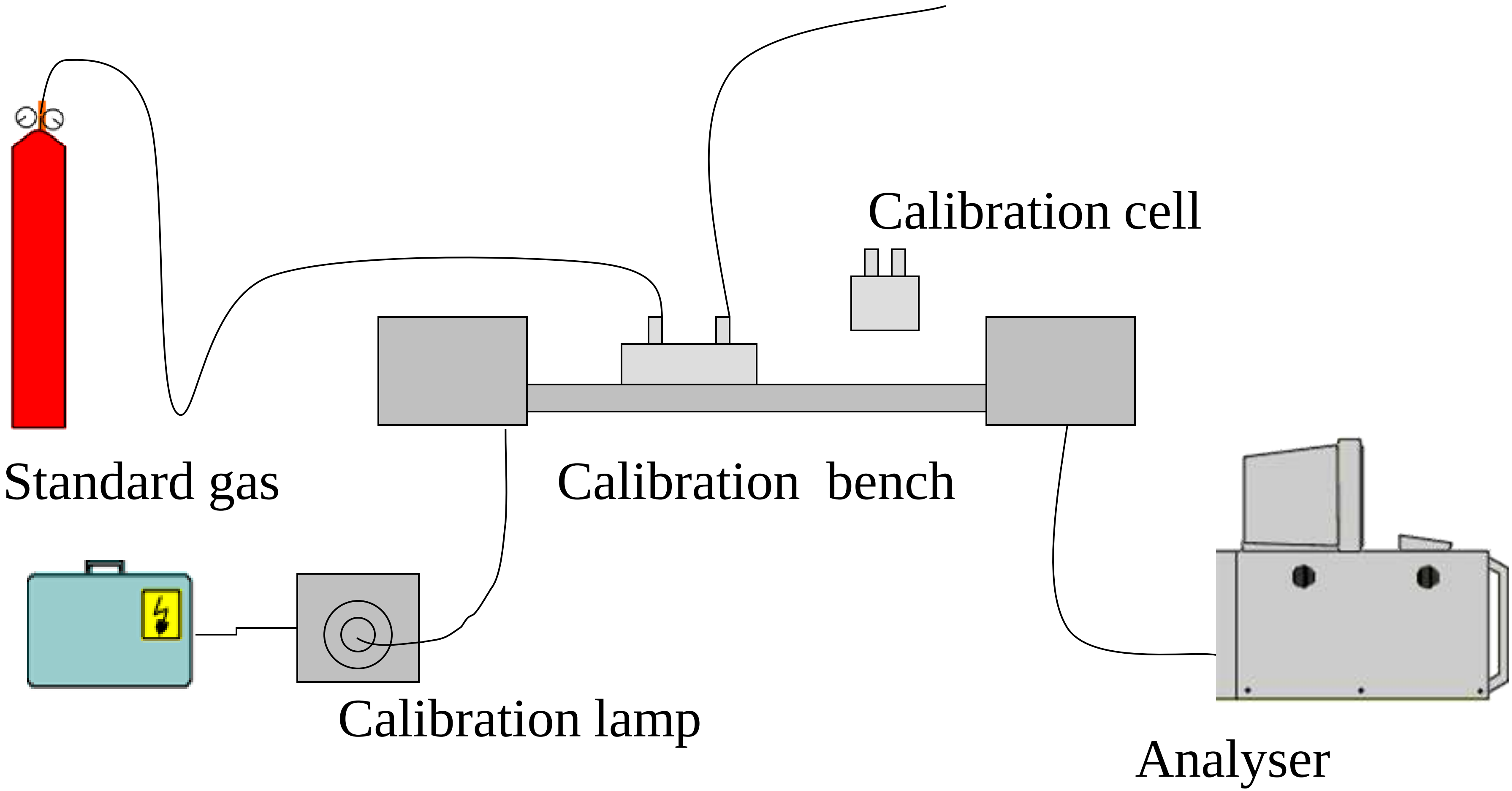


Automatic Calibration – CEM

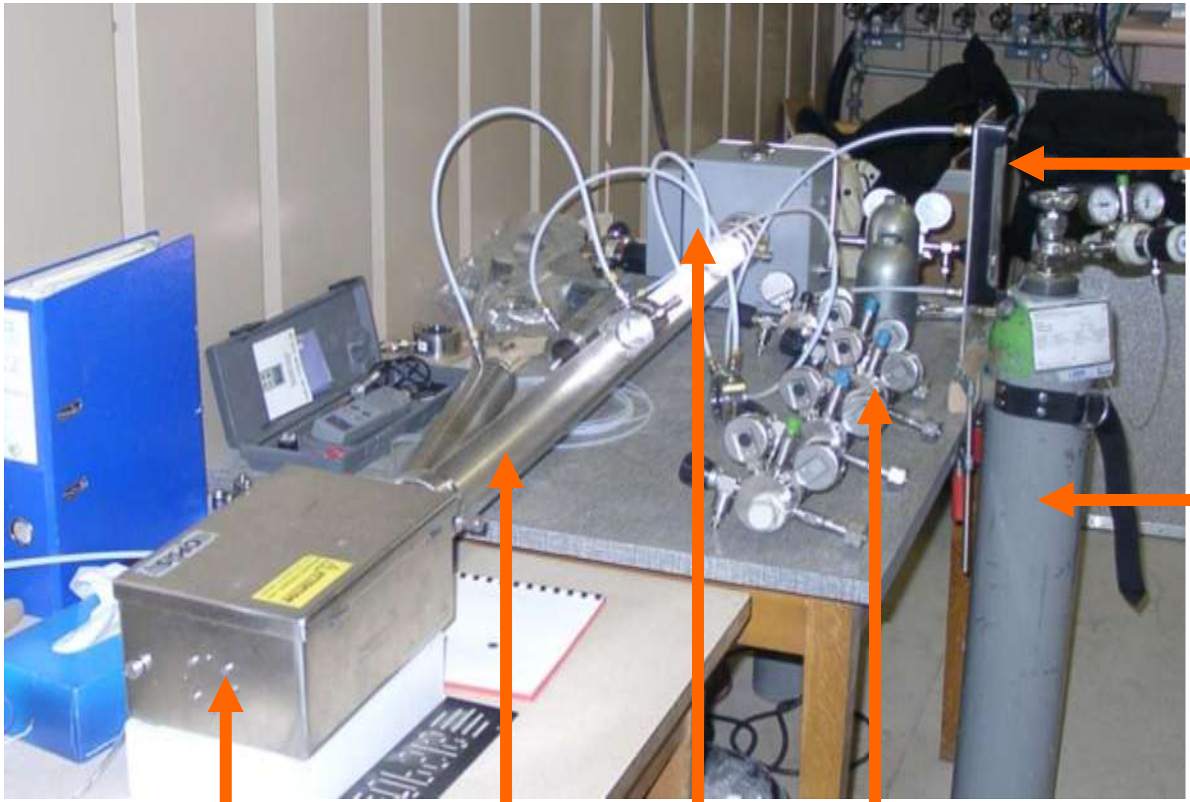


CALIBRATION

Manual span and zero bench calibration



CALIBRATION KIT



Rotameter (flow control)

Calibration gas

Receiver

Emitter with Xe lamp

Calibration bench

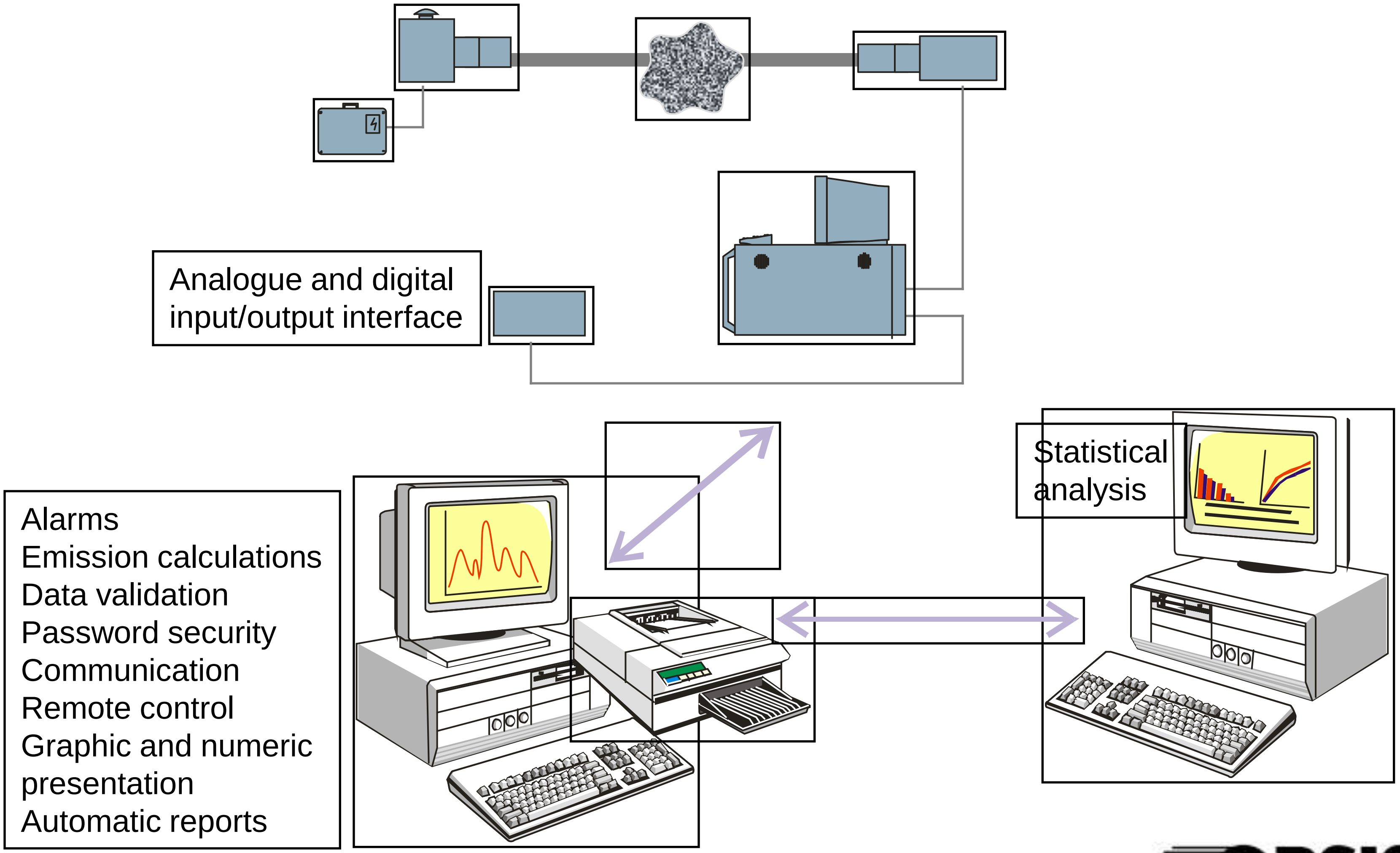
Gas valves

Performance Data (typical data which may vary depending on application)

Compound	Max. measurement range (1 m path)[1]	Lowest measurement range according to EN15267	Min. detectable quantities (monitoring path 1 m, measurement time 30 sec.)	Zero drift (1 m path, max. per month)[6]	Span drift (per month, better than)	Linearity error (of measurement range, better than)	Max. length of fibre optic cable (when monitoring individual compounds)[5]	Hardware requirement
AR600/AR620 UV/IR DOAS Analyser								
NO[2]	0–2000 mg/m³	0–150 mg/m³	1 mg/m³	±2 mg/m³	±2%	±1%	10 m	AR600/620
NO_2	0–2000 mg/m³	0–20 mg/m³	0.5 mg/m³	±1 mg/m³	±2%	±1%	200 m	AR600/620
SO_2	0–5000 mg/m³	0–80 mg/m³	0.5 mg/m³	±1 mg/m³	±2%	±1%	100 m	AR600/620
NH_3[3]	0–1000 mg/m³	0–10 mg/m³	0.5 mg/m³	±1 mg/m³	±2%	±1%	10 m	AR600/620
Hg^0[2]	0–1000 µg/m³	0–45 µg/m³	0.5 µg/m³	±1 µg/m³	±2%	±1%	50 m	AR600/620
Hg^{tot}	0–1000 µg/m³	0–45 µg/m³	0.5 µg/m³	±1 µg/m³	±2%	±1%	50 m	AR600
H_2O	0–100% Vol.	0–30% Vol.	0.5% Vol.	±1% Vol.	±2%	±1%	100 m	AR620
HCl	0–10000 mg/m³	—	10 mg/m³ [4]	±20 mg/m³ [4]	±2%	±1%	50 m	AR620
HF	0–1000 mg/m³	—	5 mg/m³	±10 mg/m³	±2%	±1%	200 m	AR620
CO_2	0–100% Vol.	—	0.5% Vol.	±1% Vol.	±2%	±1%	50 m	AR620
Benzene	0–1000 mg/m³	—	1 mg/m³	±2 mg/m³	±2%	±1%	25 m	AR600/620
Formaldehyde	0–1000 mg/m³	0–20 mg/m³	1 mg/m³	±2 mg/m³	±2%	±1%	25 m	AR600/620
AR650 IR DOAS Analyser								
HCl	0–5000 mg/m³	0–15 mg/m³	0.5 mg/m³	±1 mg/m³	±2%	±1%	50 m	AR650
CO	0–10000 mg/m³	0–75 mg/m³	3 mg/m³	±6 mg/m³	±2%	±1%	10 m	AR650
H_2O	0–100% Vol.	0–30% Vol.	0.1% Vol.	±0.2% Vol.	±2%	±1%	100 m	AR650
HF	0–1000 mg/m³	0-5 mg/m³	0.2 mg/m³	±0.4 mg/m³	±2%	±1%	200 m	AR650
NH_3	0–1000 mg/m³	—	2 mg/m³	±4 mg/m³	±2%	±1%	200 m	AR650
N_2O	0–10000 mg/m³	0-100 mg/m³	2 mg/m³	±4 mg/m³	±2%	±1%	50 m	AR650
CH_4	0–10000 mg/m³	0-15 mg/m³	0.5 mg/m³	±1 mg/m³	±2%	±1%	100 m	AR650
CO_2	0–100% Vol.	—	0.1% Vol.	±0.2% Vol.	±2%	±1%	50 m	AR650
LD500 Laser Diode Gas Analyser								
HCl	0–5000 mg/m³	—	0.5 mg/m³	±1 mg/m³	±2%	±1%	500 m*	LD500
CO	0–100% Vol.	—	0.1% Vol.	±0.2% Vol.	±2%	±1%	500 m*	LD500
H_2O	0–100% Vol.	—	0.1% Vol.	±0.2% Vol.	±2%	±1%	500 m*	LD500
HF	0–5000 mg/m³	—	0.05 mg/m³	±0.1 mg/m³	±2%	±1%	500 m*	LD500
NH_3	0–5000 mg/m³	—	0.5 mg/m³	±1 mg/m³	±2%	±1%	500 m*	LD500
CO_2	0–100 g/m³	—	0.1% Vol.	±0.2% Vol.	±2%	±1%	500 m*	LD500
O_2	0–21%	—	0.1% Vol.	±0.2% Vol.	±2%	±1%	500 m*	LD500
CH_4	0–10000 mg/m³	—	1 mg/m³	±2 mg/m³	±2%	±1%	500 m*	LD500
Temperature	0–1400°C	—	5°C	±10°C	±2%	±1%	500 m*	LD500

(1) This data refers to a light path of 1 m. For longer paths the maximum range is proportionally smaller. Products are available to create shorter paths in very wide stacks.
(2) Maximum SO_2 concentration: 5 g/m³ × m.
(6) For AR650 the same values are valid as maximum zero drift per year.
* Laser and communication cables.
· Recommended monitoring path length: 1 to 5 m.

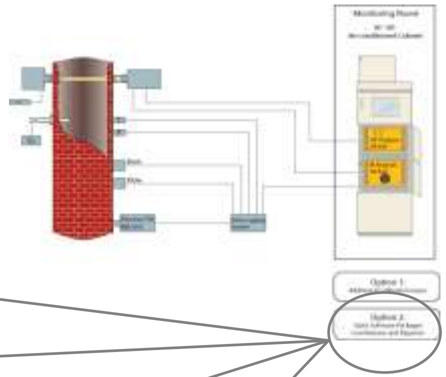
Opsis Software Packages

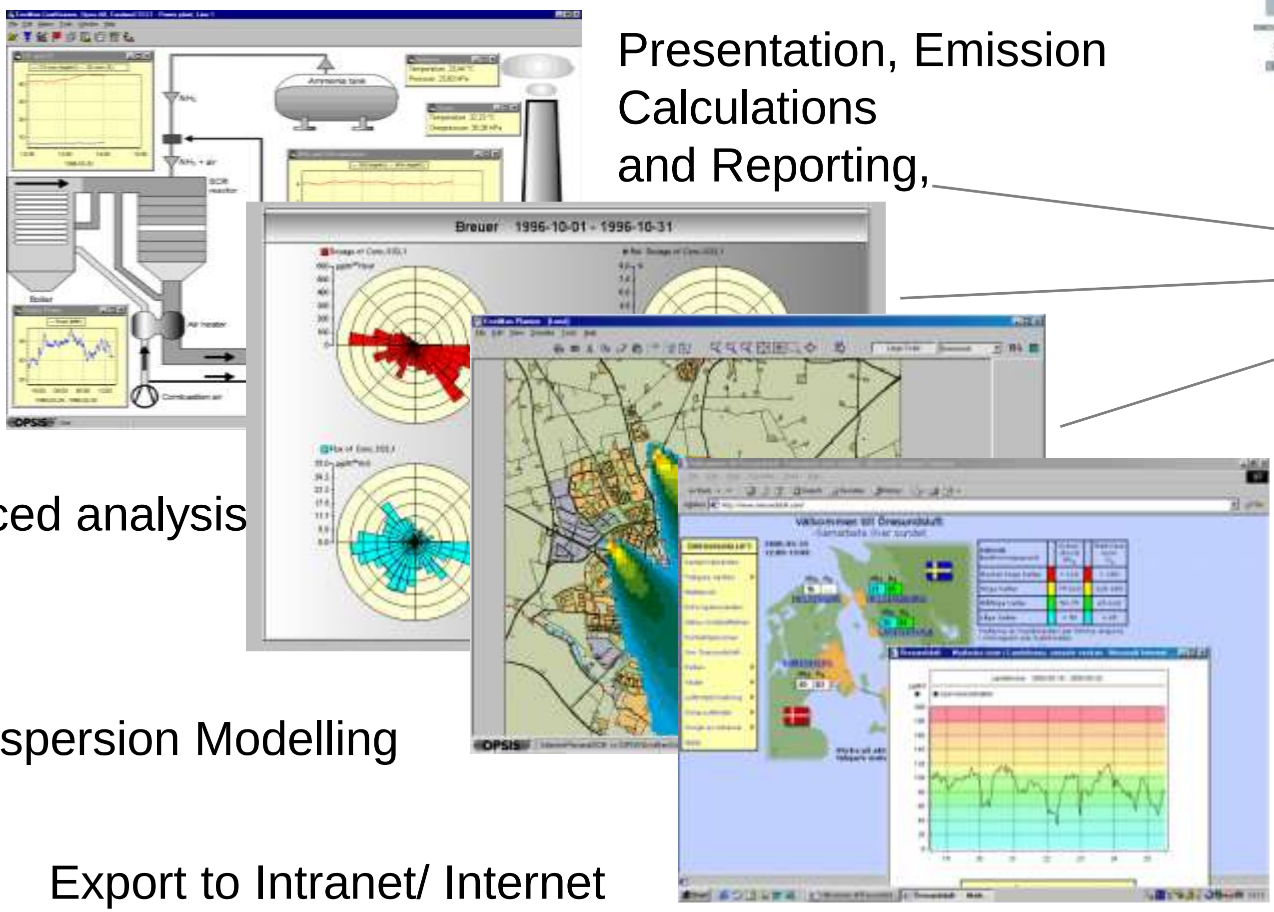


Software Products - EnviMan

Data Acquisition and Validation

Presentation, Emission Calculations
and Reporting,





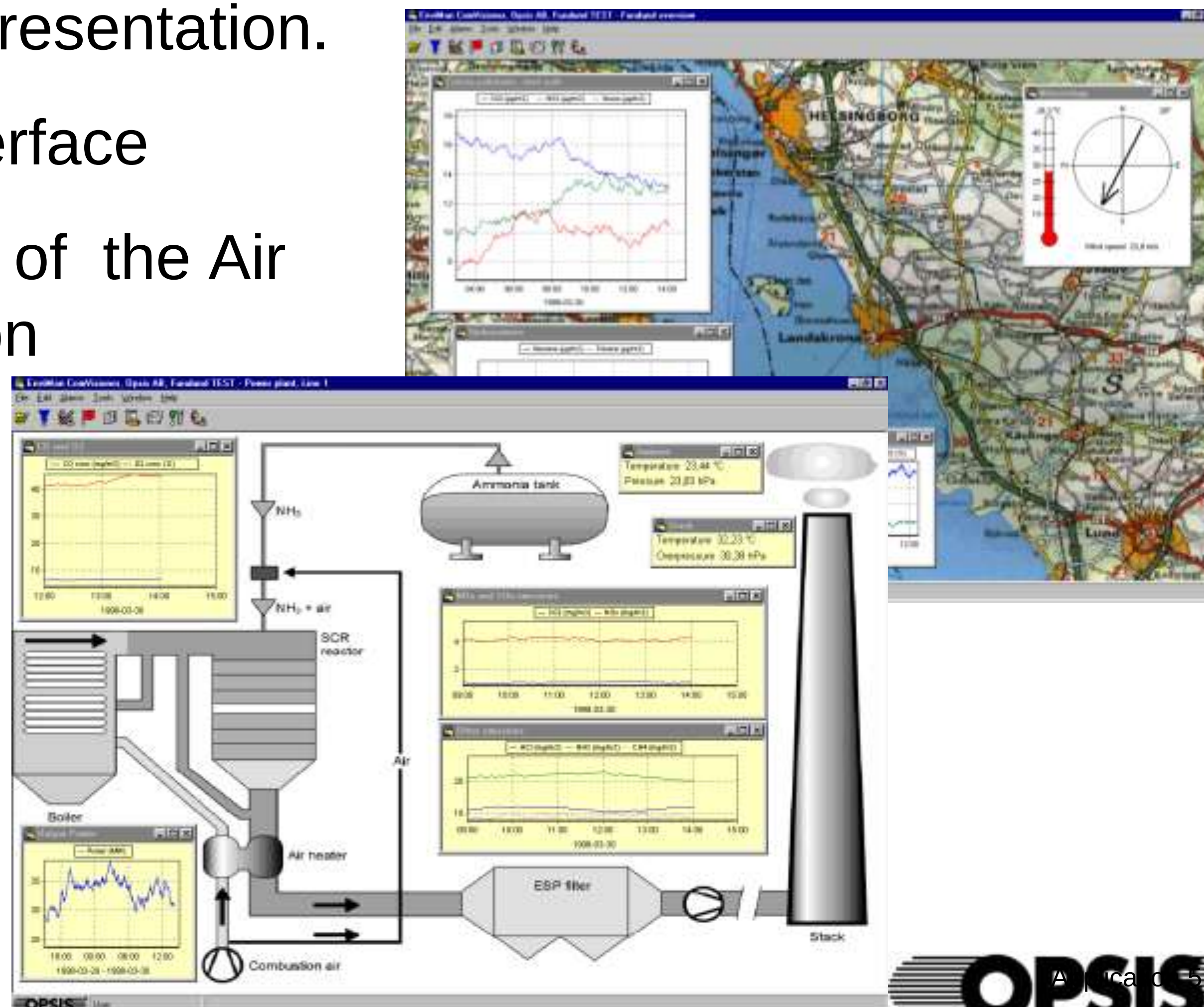
Advanced analysis of data

Dispersion Modelling

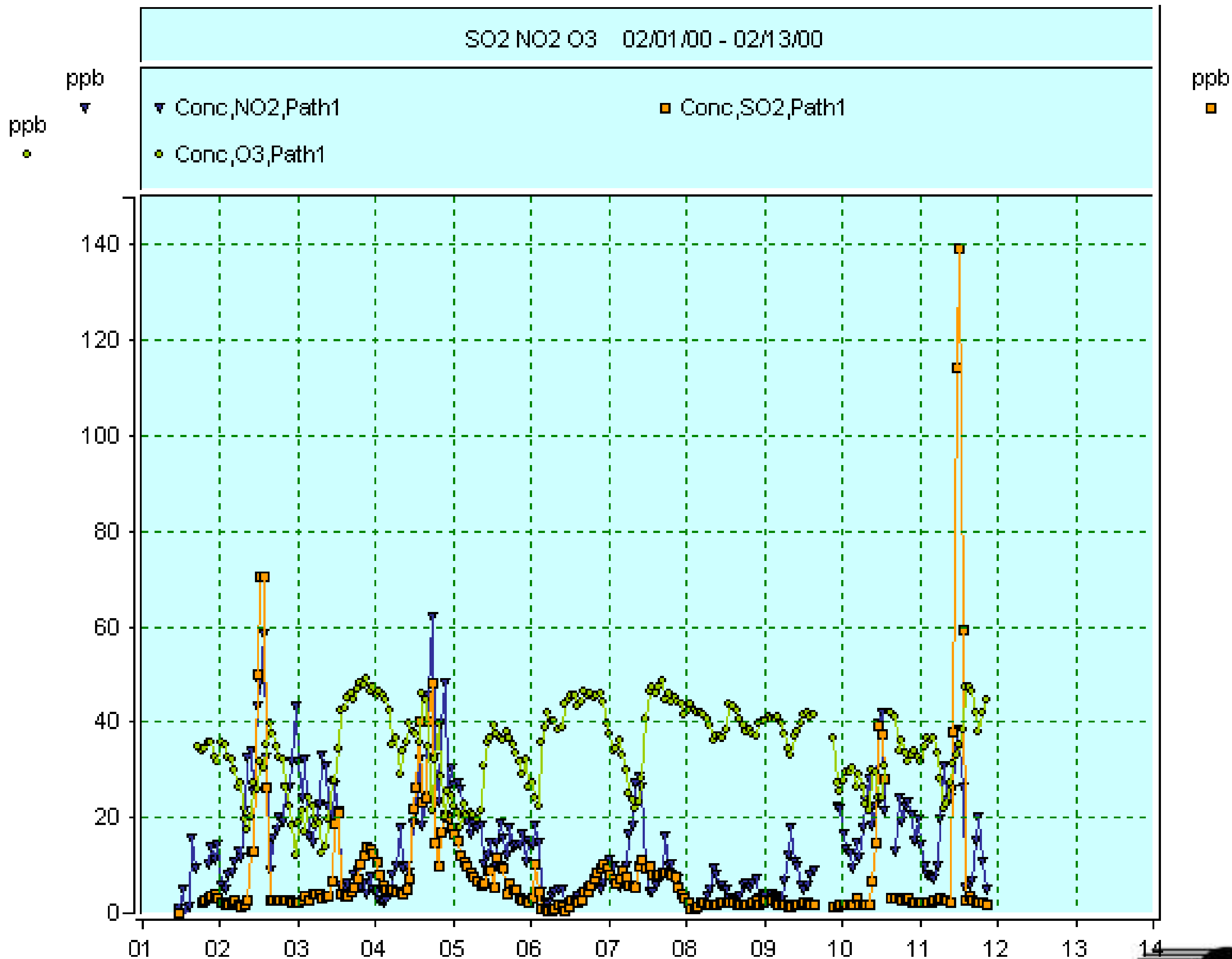
Export to Intranet/ Internet

Presentation of AQM and CEM Data

- Real-time data presentation.
- User friendly interface
- Instant feedback of the Air Pollution Situation



DATA PRESENTATION



Enviman Reporter

OPSIS

EMISSION CALCULATIONS

Unit 5	SO2	G2P7	Concentration/ Stn #1 path #1 gas #2	13.301 mg/Nm3	13.301 mg/Nm3
Unit 5	NO	G2P8	Concentration/ Stn #1 path #1 gas #3	145.458 mg/Nm3	145.458 mg/Nm3
Unit 5	NO2	G2P9	Concentration/ Stn #1 path #1 gas #4	0.000 mg/Nm3	0.000 mg/Nm3
Unit 5	H2O	G2P10	Concentration/ Stn #1 path #1 gas #1	58.366 g/Nm3	58.366 g/Nm3
Unit 5	NH3	G2P11	Concentration/ Stn #1 path #1 gas #5	0.000 mg/Nm3	0.000 mg/Nm3
Unit 5	CO2	G2P12	Concentration/ Stn #1 path #1 gas #6	218.640 g/Nm3	218.640 g/Nm3
Unit 5	O2	G2P13	Logger value/ Stn #1 ch #1	3.151 %	3.151 %
Unit 5	Temperature	G2P14	Logger value/ Stn #1 ch #4	76.627 °C	76.627 °C
Unit 5		G2P15			
Unit 5	H2O v/v	G2P16	Mathematics/ 0.124*P10	7.237 %	7.237 %
Unit 5	O2 dry	G2P17	Mathematics/ P13 / (1-P16/100)	3.397 % tg	3.397 % tg
Unit 5	SOx v/v	G2P18	Mathematics/ P7/(1-G1P7/100)/(1-P16/100)/(1-P17/21)*0.	5.816 ppm ot	5.816 ppm ot
Unit 5	NOx v/v	G2P19	Mathematics/ (1.533*P8)/(1-G1P6/100)/(1-P16/100)/(1-P1	136.504 ppm ot	136.504 ppm ot
Unit 5	NH3 v/v	G2P20	Mathematics/ P11 / (1-P16/100) / (1-P17/21) * 1.316	0.000 ppm ot	0.000 ppm ot
Unit 5	CO2 v/v	G2P21	Mathematics/ P12 / (1-P16/100) / (1-P17/21) * 0.0509	14.312 % ot	14.312 % ot
Unit 5		G2P22			
Unit 5		G2P23			
Unit 5		G2P24			
Unit 5	Flue gas flow	G2P25	Mathematics/ G1P1*P2 + G1P3*G1P5*P3/1000	84.024 kNm3to/h	84.024 kNm3to/h
Unit 5		G2P26			
Unit 5	NOx estim. emission	G2P27	Mathematics/ 0.22*P4+0.00001	20.486 kg/h	20.486 kg/h
Unit 5	NOx emission	G2P28	Mathematics/ 2.10*P19*P25/1000	24.086 kg/h	24.086 kg/h
Unit 5	NOx spec. emission	G2P29	Mathematics/ P28 / P4 / 0.0036	71.850 mg/MJ	71.850 mg/MJ
Unit 5	S estim. emission	G2P30	Mathematics/ P31	0.718 kg/h	0.718 kg/h
Unit 5	Sulphur emission	G2P31	Mathematics/ 1.47*P18*P25/1000	0.718 kg/h	0.718 kg/h
Unit 5	S spec. emission	G2P32	Mathematics/ P31 / P4 / 0.0036	2.143 mg/MJ	2.143 mg/MJ
Unit 5		G2P33			
Unit 5	NOx penalty emission	G2P34	Mathematics/ G1P28 * P4 * 0.0036	83.808 kg/h	83.808 kg/h
Unit 5	NOx emission (fee)	G2P35	Mathematics/ 2.10*P19*P25/1000	24.086 kg/h	24.086 kg/h
Unit 5	NOx fee	G2P36	Mathematics/ 5*P35	120.431 USD/h	120.431 USD/h
Unit 5		G2P37			
Unit 5		G2P38			

Test

Close

Automatic Reports

Report preview

Opsis AB, Furulund, Concentration summary

OPSIS AB

Report day 1998-09-22

Time	Furulund SO2 conc, Path 1 µg/m3	Furulund NO2 conc, Path 1 µg/m3	Furulund O3 conc, Path 1 µg/m3	Furulund Benzene, Path 1 µg/m3	Furulund Toluene, Path 1 µg/m3	Furulund Formal-dehyde µg/m3
00:00	2.38	8.46	57.78	11.71	17.80	12.14
01:00	3.03	6.38	56.77	12.67	17.34	11.53
02:00	3.25	8.67	51.32	12.33	18.77	11.33
03:00	3.57	10.25	50.01	11.09	15.20	10.04
04:00	6.96	19.34	44.61	9.58	15.83	10.03
05:00	7.34	19.63	47.43	9.99	14.11	10.27
06:00	9.09	24.32	39.53	8.72	10.38	7.89
07:00	6.23	35.15	30.69	7.64	12.99	4.81
08:00	3.20	35.12	31.84	7.53	16.33	4.78
09:00	2.50	32.86	40.17	9.25	18.38	5.99
10:00	2.55	27.81	54.62	9.15	18.83	7.51
11:00	3.10	24.20	52.74	11.87	18.39	8.17
12:00	3.08	20.38	70.63	10.55	17.69	9.29
13:00	2.15	16.14	77.52	12.51	17.13	10.88
14:00	1.70	16.45	78.15	11.21	16.24	10.90
15:00	1.76	17.57	74.07	12.36	16.40	10.78
16:00	1.67	20.47	71.05	11.17	18.80	9.95
17:00	1.56	20.82	71.97	11.47	17.85	9.83
18:00	1.93	26.11	64.96	10.71	18.67	8.65
19:00	1.57	16.61	58.60	11.79	18.14	10.83
20:00	1.62	12.54	59.77	10.91	16.88	11.61
21:00	1.44	12.21	57.81	12.38	16.21	11.21
22:00	1.71	12.21	53.72	12.38	16.10	11.26
23:00	1.65	8.82	56.42	11.65	15.31	11.62
Mean	3.16	18.85	60.25	10.87	16.66	9.67
Max	9.09	35.15	78.15	12.67	18.83	12.14
Sum						
Meas.	24	24	24	24	24	24
Cover.	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

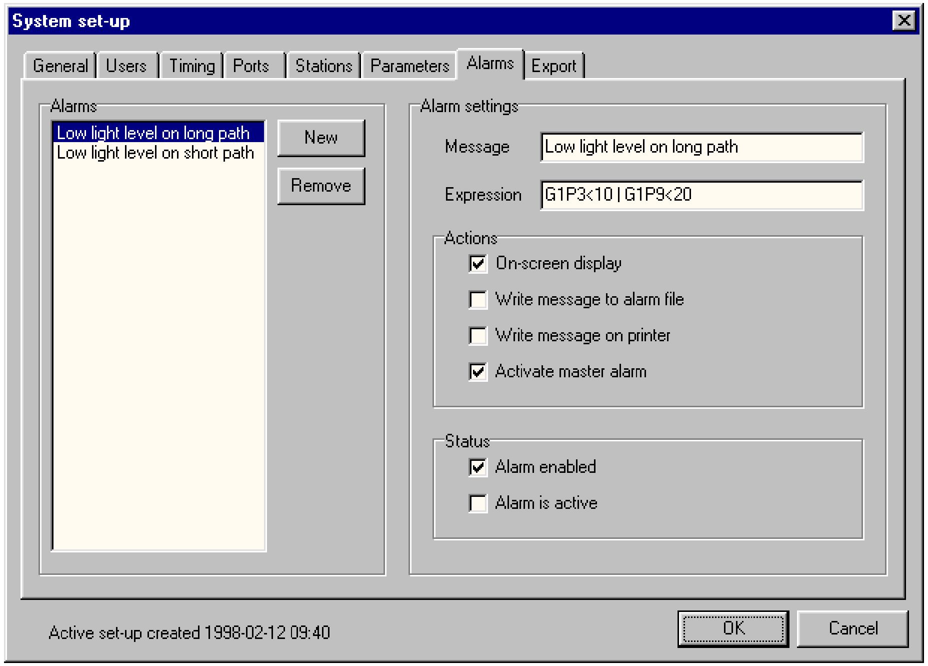
Values with a star (*) in front are estimated.

Report created 1998-10-28 13:23:46 Signature:

Print Close

ALARM HANDLING

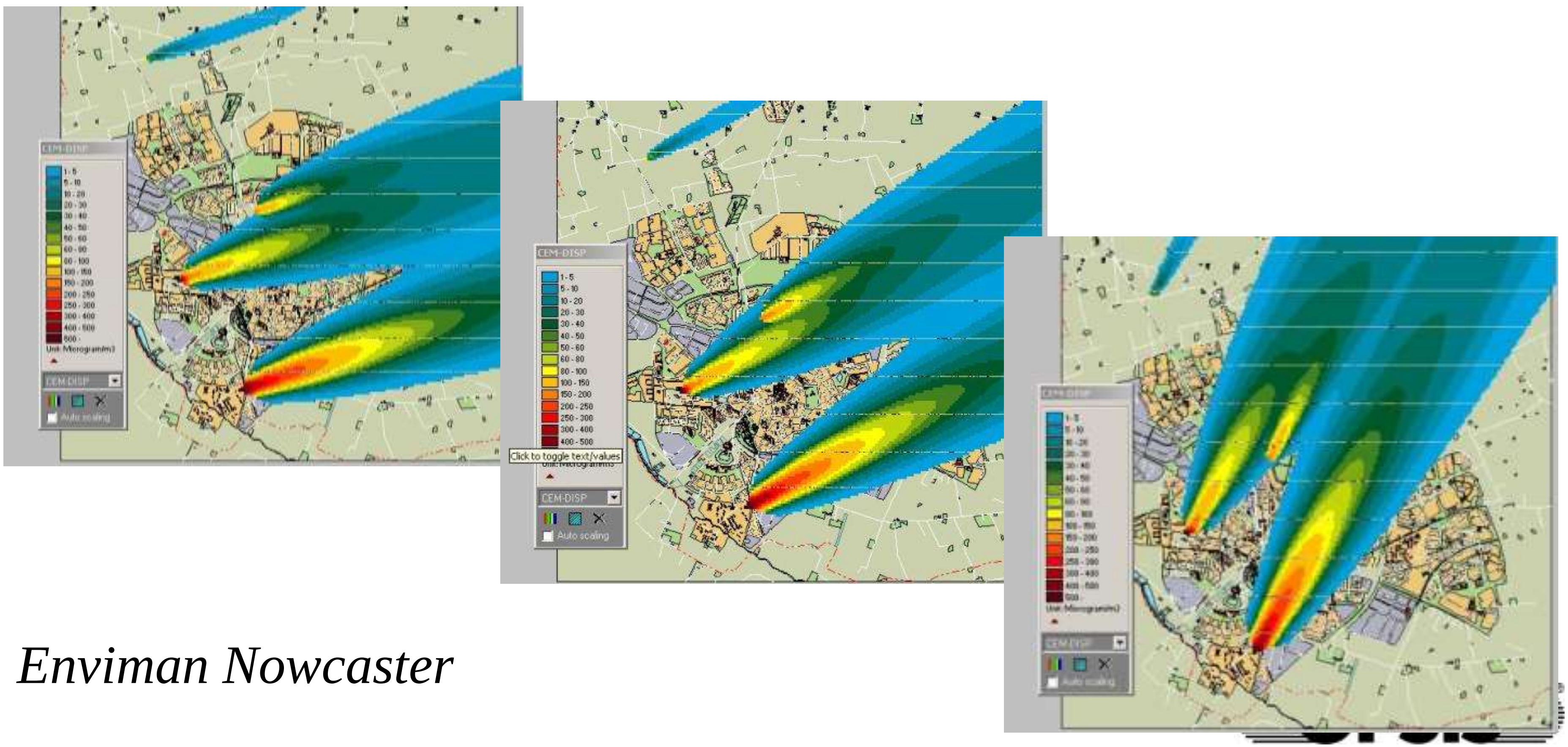
- Data exceeding the given level will trigger an alarm.
- Data will be marked and operators alerted.
- Alarm export to almost any output.



Enviman ComVisioner

MODELAGEM EM TEMPO REAL

Real time CEMS and metereological data is used as input for the dispersion model.
The impact from industrial emissions can be followed with less than 5 minute intervals



Enviman Nowcaster

OPSIS AB

- Fundada em 1985 por Svante Wallin e Leif Unéus
- Localizada em Furulund, Sweden.

TÜV Rheinland

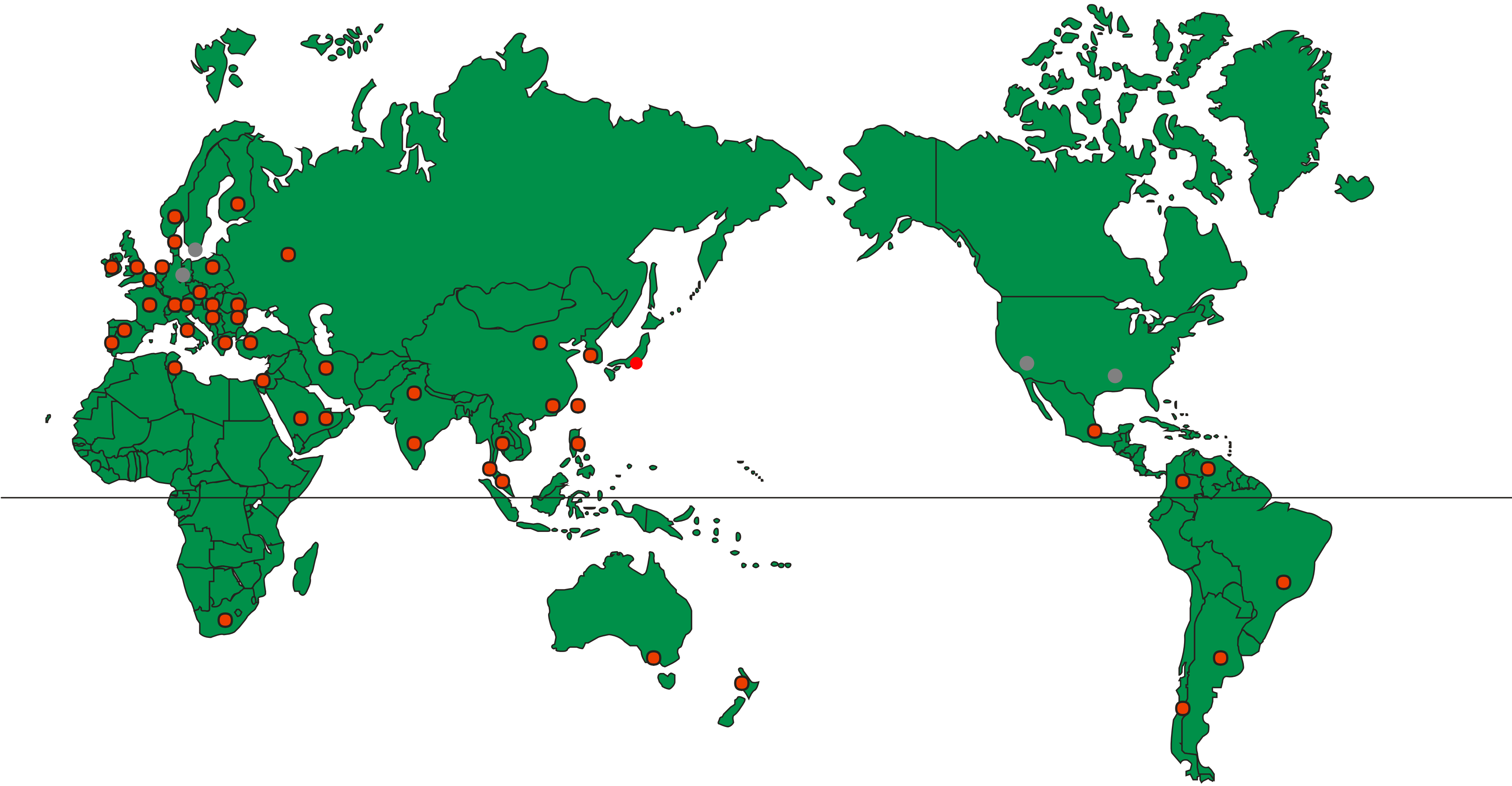
EPA United States Environmental Protection Agency

"...to protect human health and to safeguard the natural environment..."

CERTIFIED ISO 9001 ISO 14001 SEMKO-DEKRA

OPSIS

Presença mundial



OPSIS®

Coprocessamento Referencias

- Cerca de 90 sistemas
- Europa 50
- HOLCIM, 26 systems
- LAFARGE, 14 systems

WORLDWIDE REFERENCES

Merone, Italy

Cementos Bocaya, Colombia

Aalborg, Denmark

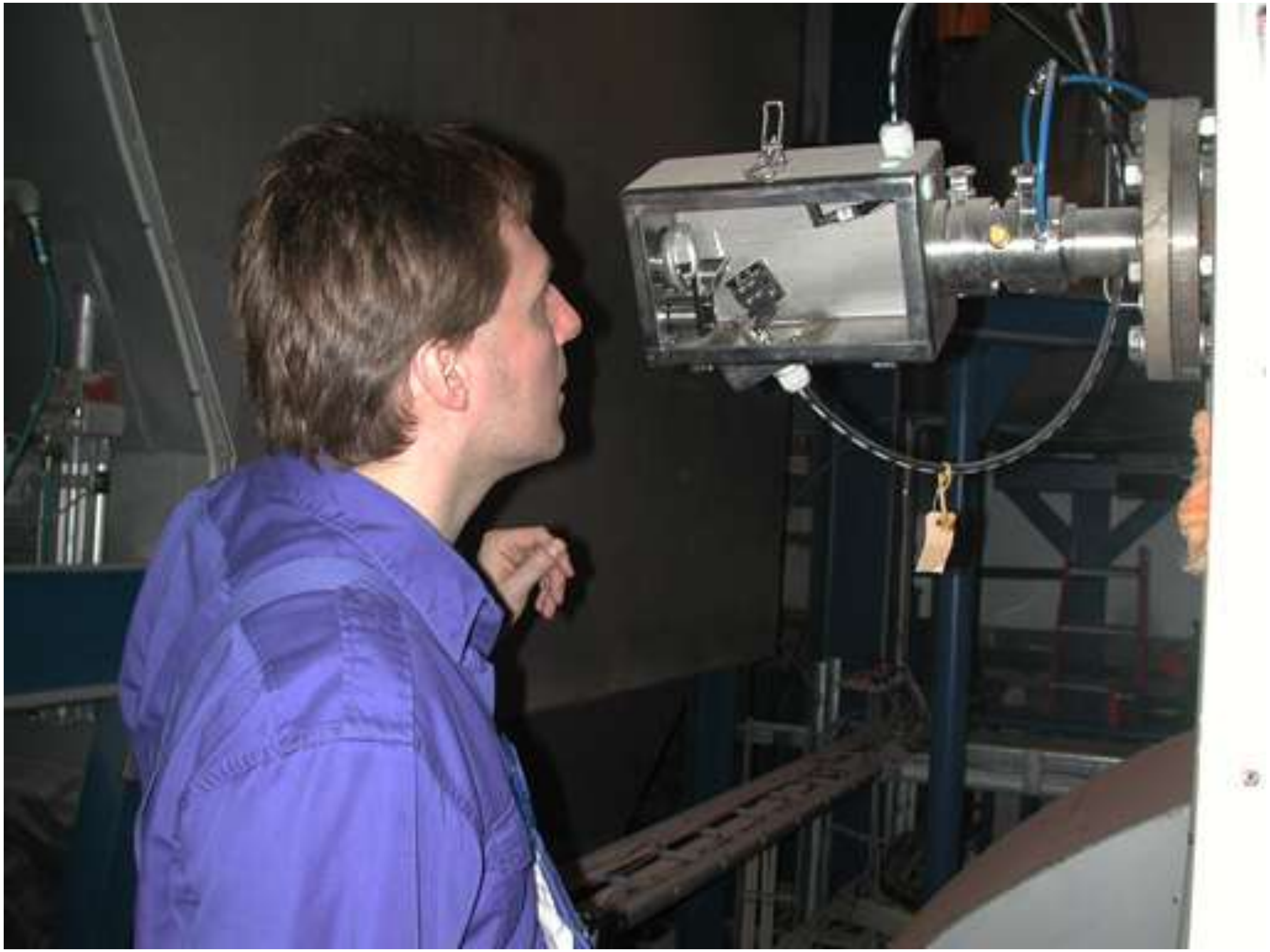
Alpha Cement,South Africa

Main Stack

CEM location

EMITTER

RECEIVER



EMITTER WITH PURGE AIR CASSETTE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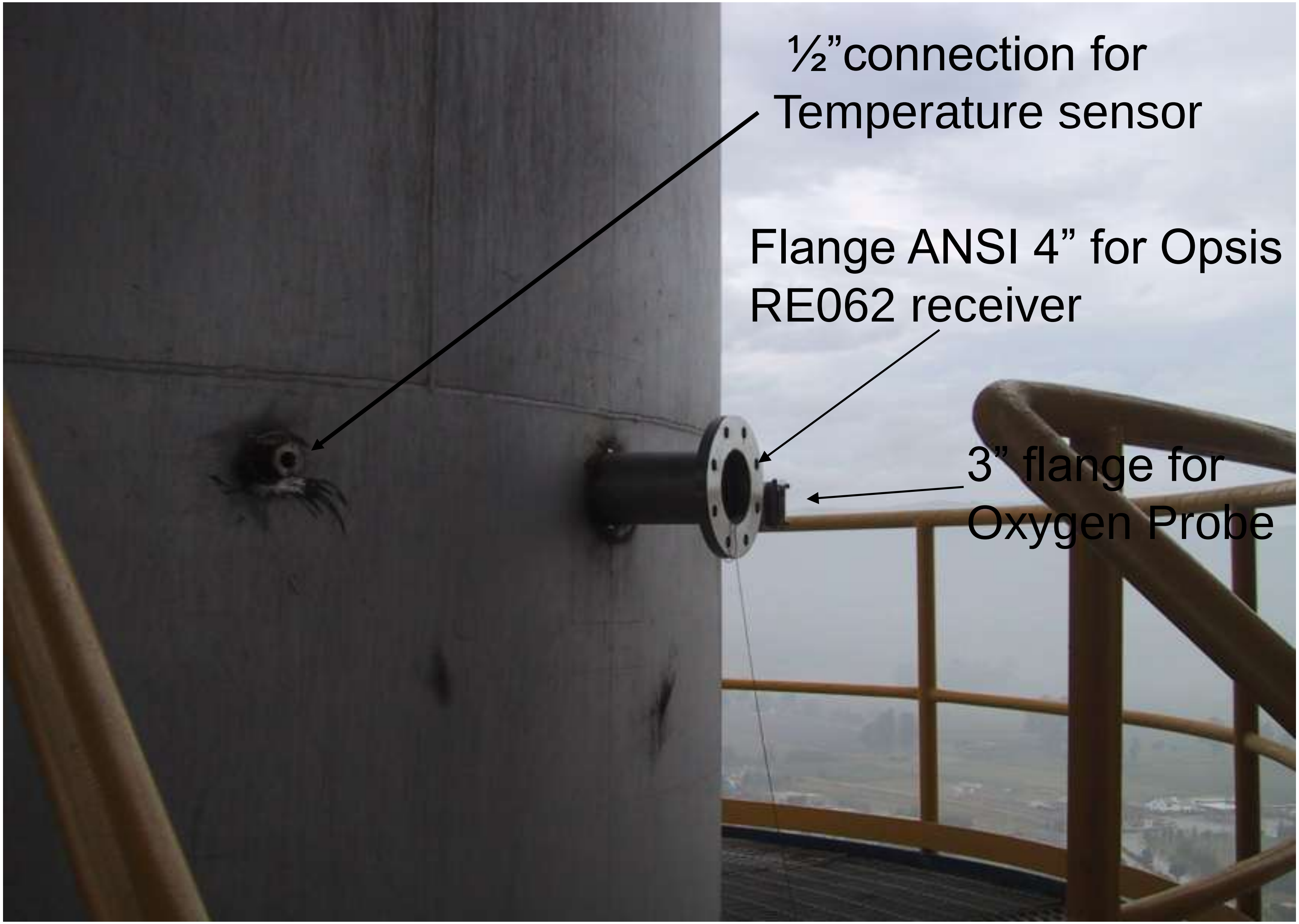
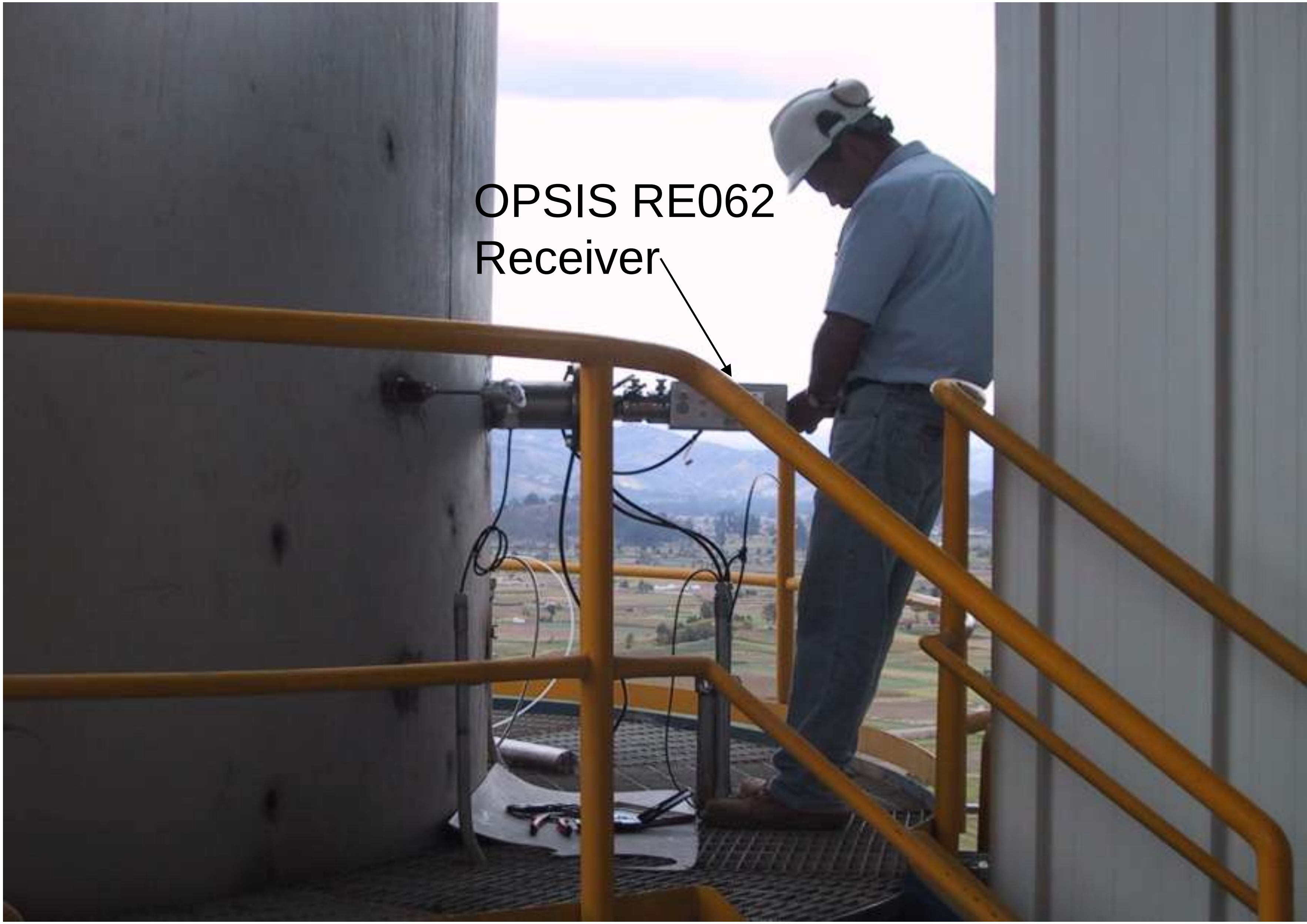
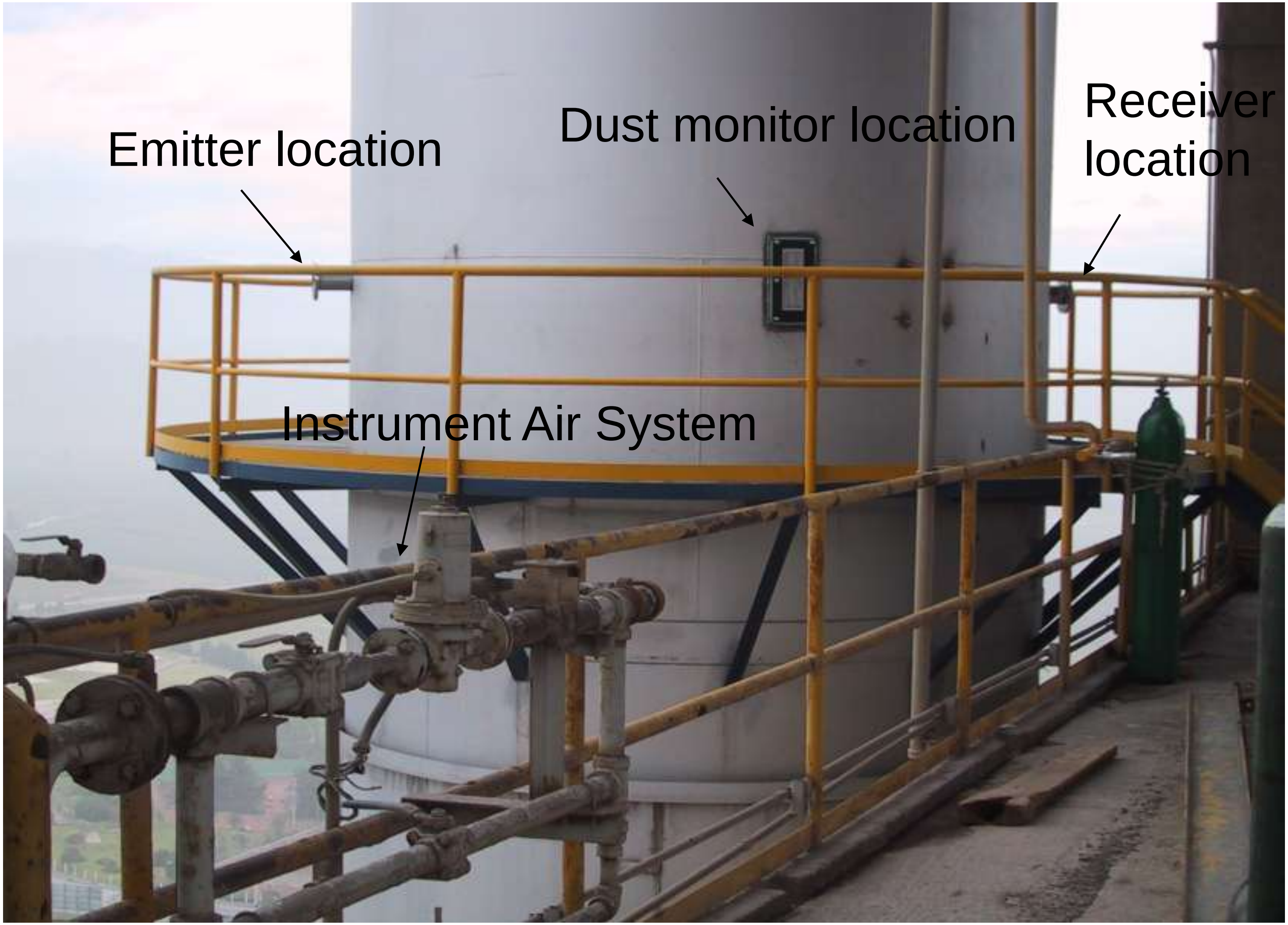
07.04.2011

Making Holes in the Stack


½”connection for Temperature sensor
Flange ANSI 4” for Opsis RE062 receiver
3” flange for Oxygen Probe


Flange ANSI 4” for
OPSIS EM062 Emitter


OPSIS RE062
Receiver


Emitter location
Dust monitor location
Receiver location
Instrument Air System

Training Session

Equipment has Arrived

Shelter on site

Shelter is close to the stack to reduce optical fibre cable lenght

OPSIS

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ANALYSER CABINET

The cabinet includes the analysers, screen, signal handling, air-conditioner and keyboard

I/O MODULES

Installing the AC181 cabinet for Opsis UV and IR analysers


OPSIS O2000
Oxygen analyser
Power Circuit Breakers
OPSIS


Conduits for cables and optical fibres
OPSIS


OPSIS
07.04.2011

OPSIS DOAS RESUMO

MULTIPLOS GASES

CL_2,HCL,HF,BTX,CH_4, Hg, NH_3 etc.

SEM AMOSTRAGEM

IN-SITU – CROSS STACK

CERTIFICAÇÃO INTERNACIONAL

Muito obrigado !