Continous Emission Monitoring of toxic and reactive gases

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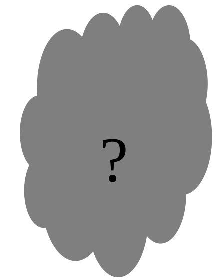
EXAMPLE :CEMENT KILN EMISSIONS

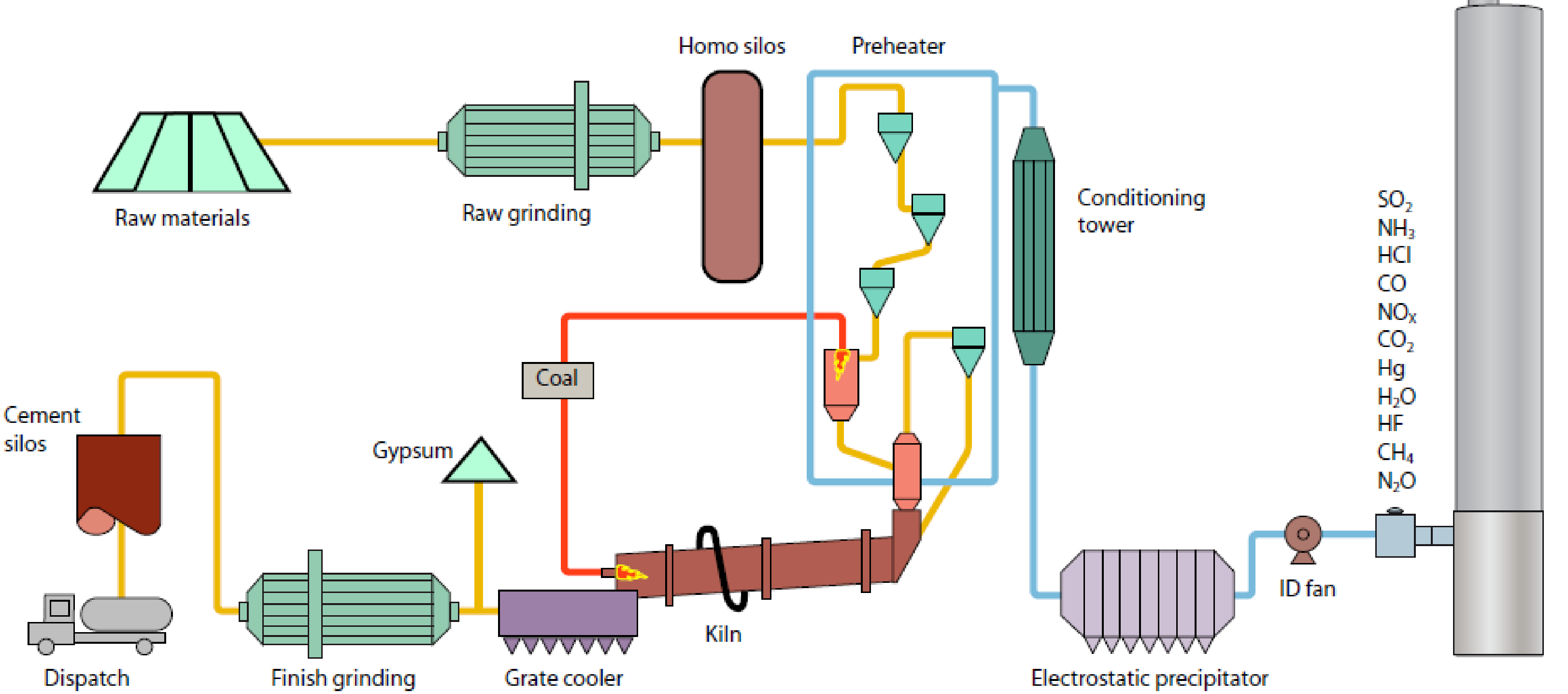
Monitoring is normally required due to environmental regulations

A limited number of parameters are monitored, typically NOx,SO2,CO,O2 and Dust/Opacity

SOURCES OF EMISSIONS

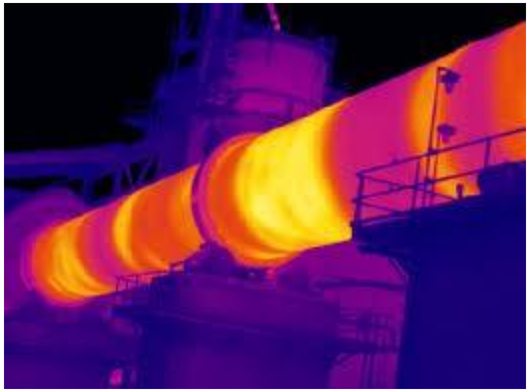
Raw material + Process + Fuel = Emissions





Cement manufacturing process

EMISSIONS FROM CEMENT PLANTS



NOX (Nitrogen Oxides) is developed during combustion of fuel and air, and is temperature dependent

SO_2 (Sulfur Dioxide) is developed from sulfur in the raw material and the fuel, and the final emissions also depends on the process used.

CO (Carbon Monoxide) is typically a result of poor combustion

CO_2 (Carbon Dioxide) , is developed from carbon content in the fuel during combustion and from processing the raw material

SPECIAL EMISSIONS

TOC (Total Organic Carbon) is developed due to heating of raw material containing hydrocarbons, and from using certain alternative fuels ,mainly consiting of Methane (CH4) and may also contain VOC´s such as Benzene, Toluene, Xylenes etc

Other gases of interest could be HCL(Hydrogen Chloride), HF,NH3 and Hg (Mercury) depending on the composition of the raw material or alternative waste co-incineration

EXAMPLE, EUROPEAN REGULATION

EC Directive 2000/76/EC applies to Waste Incineration plants and Cement plants using co-incineration

Compound			**Emission limit value 24 hour**
			(mg/m3 , NTP, 10 % O_2)
Particles			30
TOC			10
HCl			10
HF			1
SO_2			50
NO_X			800/500 (old/new plant)
CO			Set by local authority

NEW REGULATIONS FOR MERCURY

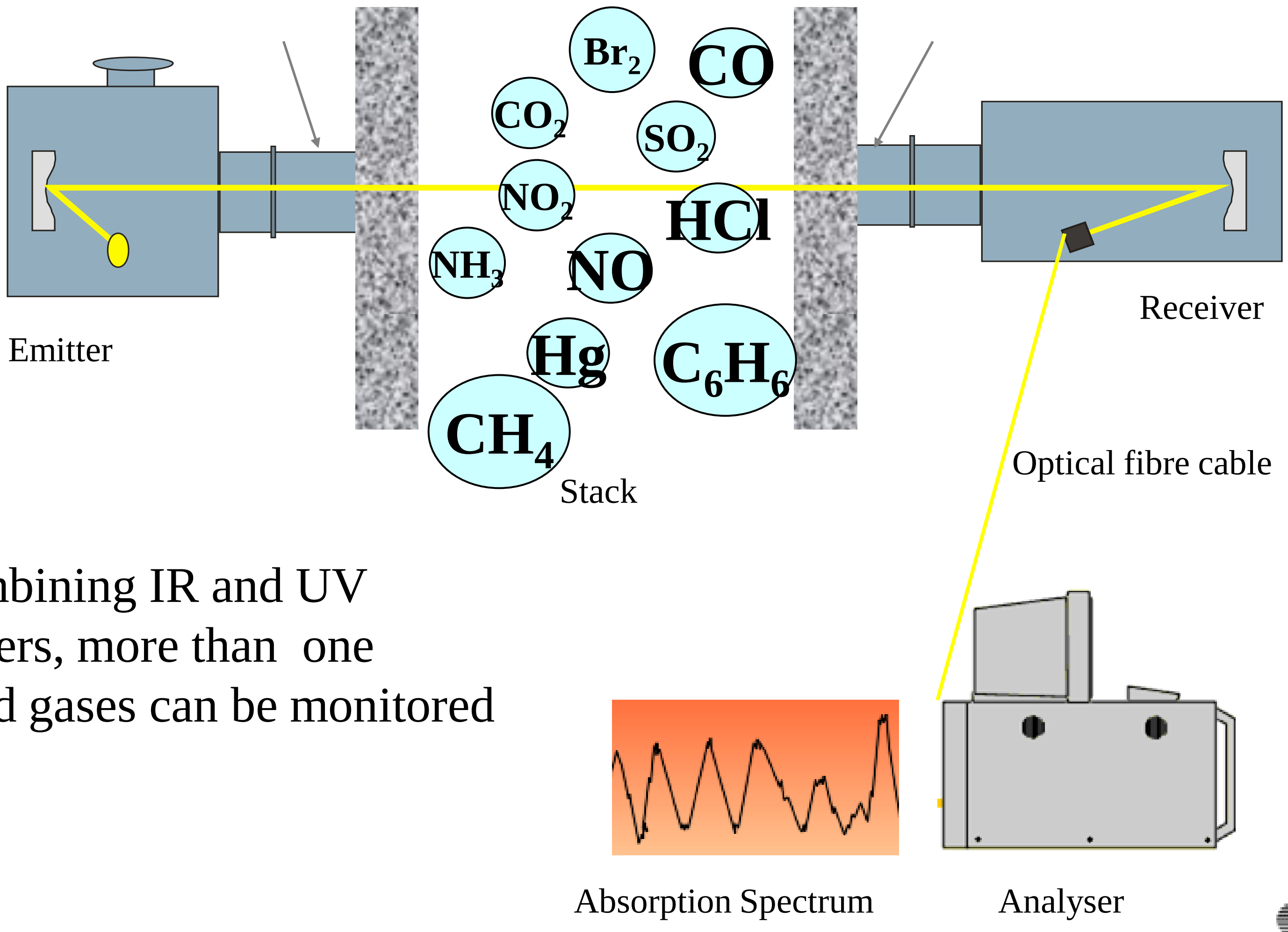
- USA, Proposed federal MATS rules for Coal Fired Power Plants , requires CEMS for continous monitoring by 2015. Limit value for coal fired plants , 0.013 lb/GWh

- USA, Existing MACT rules for Cement Plants , CEMS for continous monitoring . Limit value 10 ug/Nm3 for existing plants , 4 ug/Nm3 for new plants

- EU has ongoing discussions for new Mercury regulations.Germany and Spain already have regulations for Mercury from Waste Incineration Plants and Coal Fired Power Plants

THE DOAS MONITORING SOLUTION

(DOAS= Differential Optical Absorption Spectroscopy)



By combining IR and UV Analysers, more than one hundred gases can be monitored

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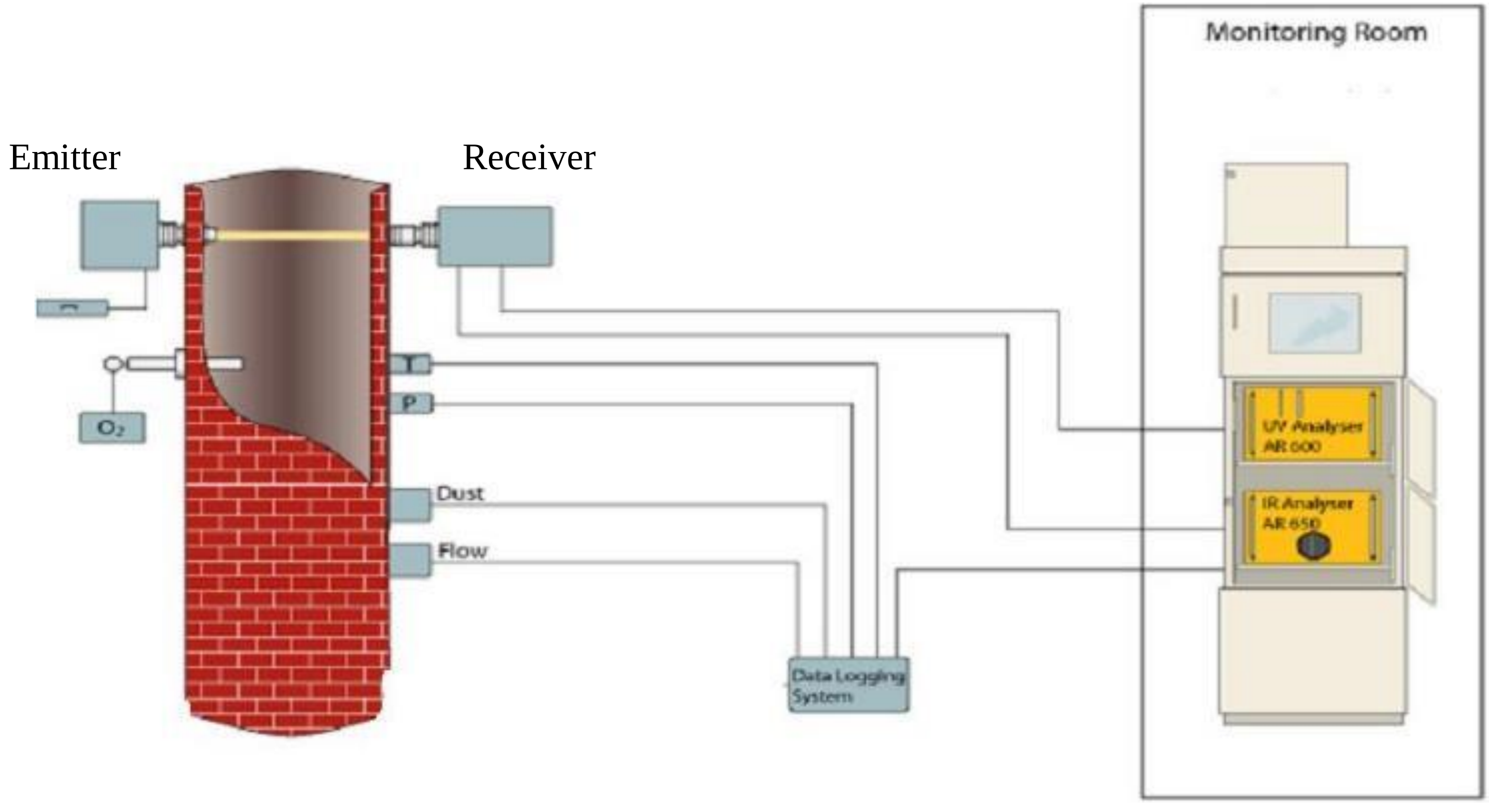
IN-SITU,NON-CONTACT,CROSS STACK MONITORING



- Non-contact measurements works well with corrosive and reactive gases
- Non Sampling Monitoring Solution,for Maximum Reliability and Minimum of Maintenance !

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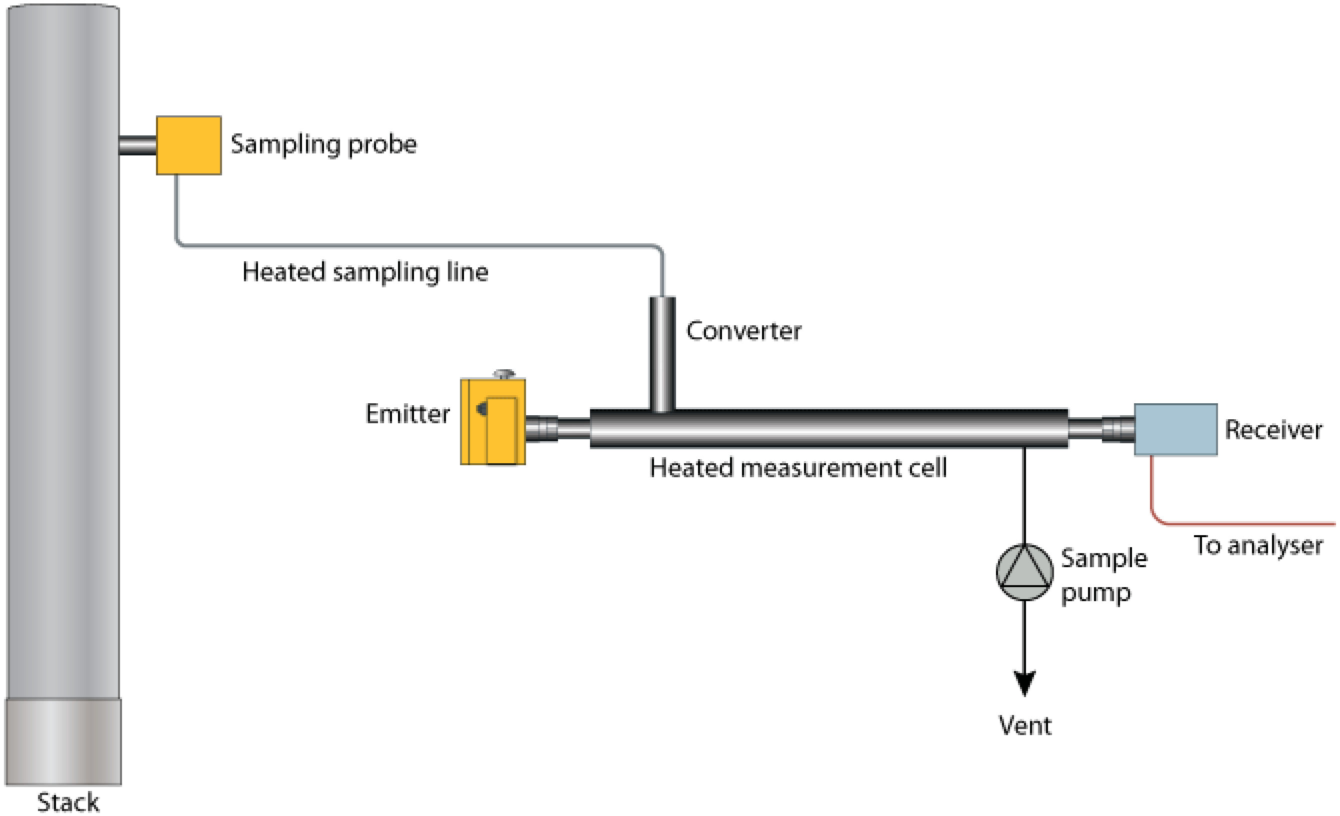
DOAS APPLICATIONS FOR MERCURY

- UV DOAS can monitor Hg^0 in situ in raw (untreated) gas
- UV DOAS + converter can monitor Hg^{TOT} in final emissions

OPSIS SYS400HG FOR TOTAL MERCURY

SYSTEM400HG OVERVIEW



MERCURY CALIBRATION

- Calibration of Hg^0 using closed cells
- Calibration of Hg^{TOT} using Hovacal gas generator

SYS400 FLEXIBILITY

- Can be configured as a dedicated system for Hg^{TOT} only
- Can be configured as a complete CEM system for Hg^{TOT} + NO, NO_2, SO_2, NH_3, CO, CO_2, O_2, H_2O, HCl, HF, CH_4…

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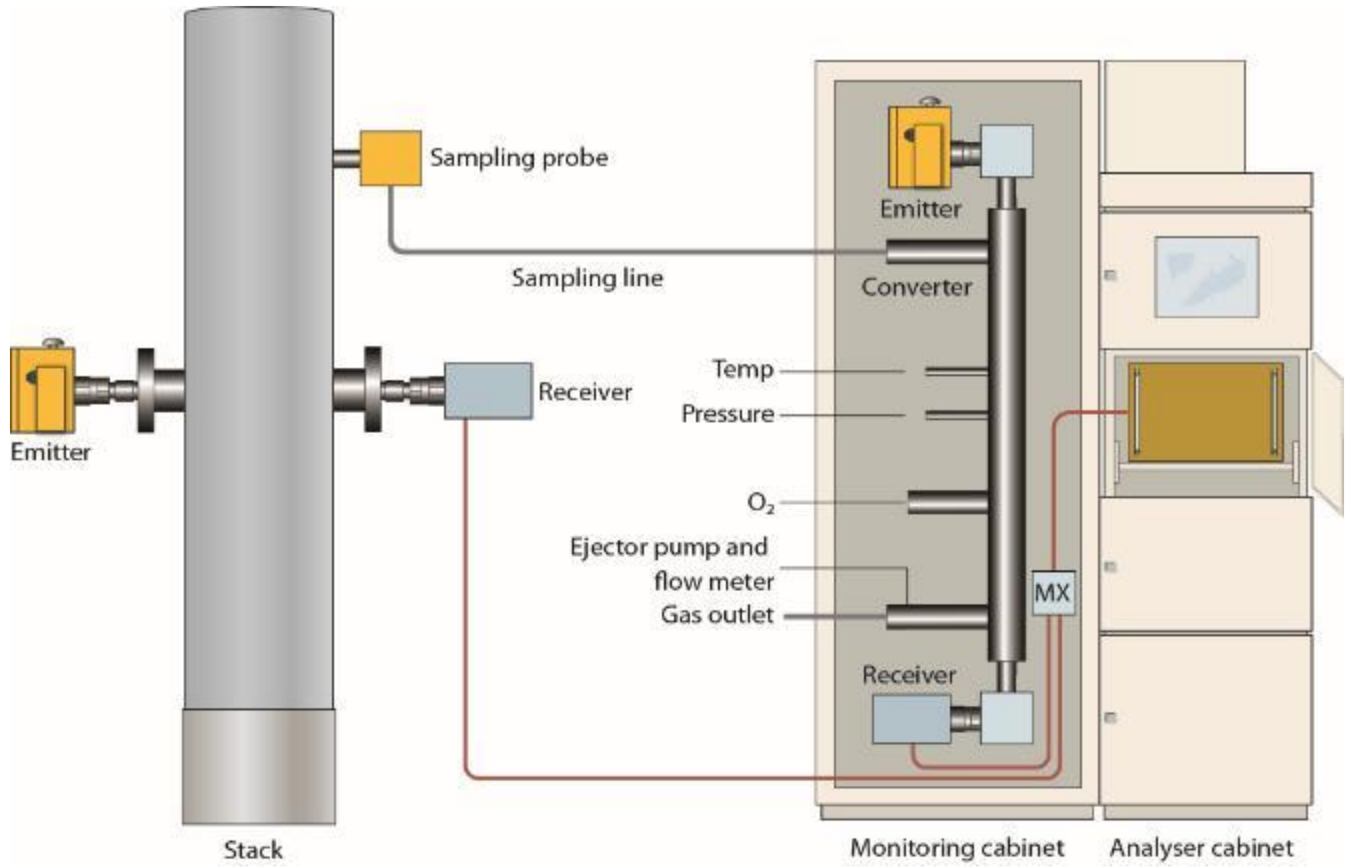
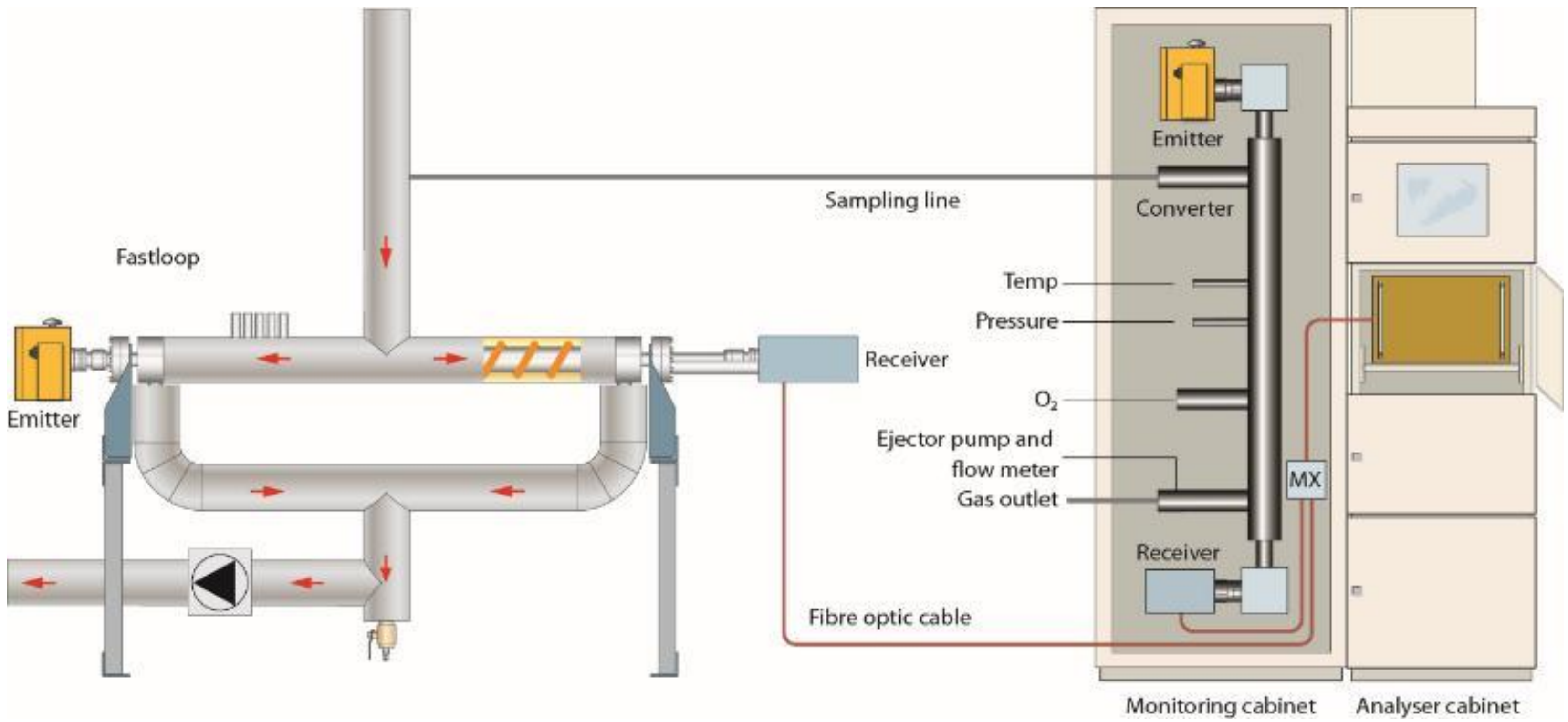
EXTRACTIVE HGTOT SYSTEM CAN BE ADDED TO EXISTING DOAS MULTIGAS CEMS



EXTRACTIVE HGTOT SYSTEM CAN BE ADDED TO EXISTING DOAS FAST LOOP SOLUTION



SYS400HG CERTIFIED BY TÜV

TÜVRheinland®
Precisely Right.

Certificate:
0000035012 / 16 March 2012

Calculation of overall uncertainty according to EN 14181 and EN 15267-3

Measuring system	
Manufacturer	Opsis AB
Name of measuring system	AR602Z/Hg
Serial number of the candidates	1498 / 1499
Measuring principle	UV - DOAS
Test report	936/21215492/A
Test laboratory	TÜV Rheinland
Date of report	2011-10-10
Measured component	Hg
Certification range	0 - 45 µg/m³

Evaluation of the cross sensitivity (CS)
(system with largest CS)

Sum of positive CS at zero point	0.00	µg/m³
Sum of negative CS at zero point	-0.50	µg/m³
Sum of postive CS at reference point	1.00	µg/m³
Sum of negative CS at reference point	-1.10	µg/m³
Maximum sum of cross sensitivities	1.20	µg/m³
Uncertainty of cross sensitivity	0.694	µg/m³

Calculation of the combined standard uncertainty

Tested parameter		u		u²	
Standard deviation from paired measurements under field conditions *	u_D	0.736	µg/m³	0.542	(µg/m³)²
Lack of fit	u_{lof}	0.404	µg/m³	0.163	(µg/m³)²
Zero drift from field test	$u_{d,z}$	-0.442	µg/m³	0.195	(µg/m³)²
Span drift from field test	$u_{d,s}$	-0.650	µg/m³	0.423	(µg/m³)²
Influence of ambient temperature at span	u_t	0.153	µg/m³	0.023	(µg/m³)²
Influence of supply voltage	u_v	0.208	µg/m³	0.043	(µg/m³)²
Cross sensitivity (interference)	u_i	0.694	µg/m³	0.481	(µg/m³)²
Influence of sample gas flow	u_p	-0.049	µg/m³	0.002	(µg/m³)²
Uncertainty of reference material at 70% of certification range	u_{rm}	0.364	µg/m³	0.132	(µg/m³)²

* The larger value is used :
"Repeatability standard deviation at span" or
"Standard deviation from paired measurements under field conditions"

Combined standard uncertainty (u_C)	$u_c = \sqrt{\sum (u_{max,j})^2}$	1.42	µg/m³
Total expanded uncertainty	$U = u_c * k = u_c * 1.96$	2.78	µg/m³

Relative total expanded uncertainty	**U in % of the ELV 30 µg/m³**	**9.3**
Requirement of 2000/76/EC and 2001/80/EC	**U in % of the ELV 30 µg/m³**	**40.0**
Requirement of EN 15267-3	U in % of the ELV 30 µg/m³	30.0

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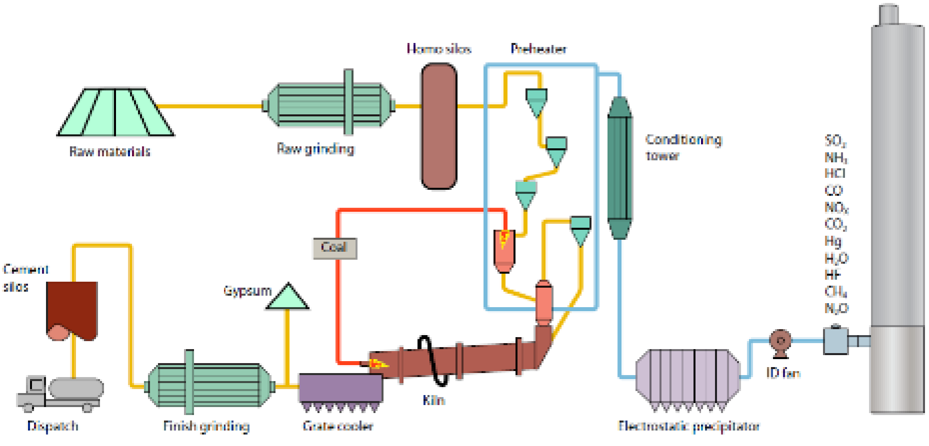
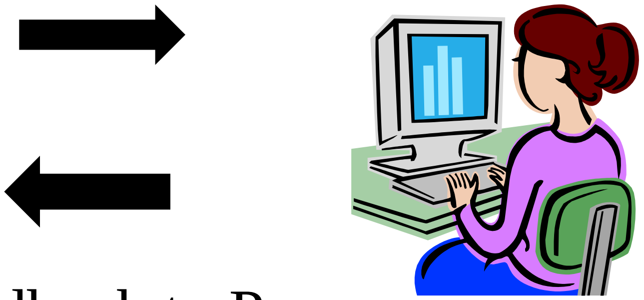
PROCESS CONTROL APPLICATIONS



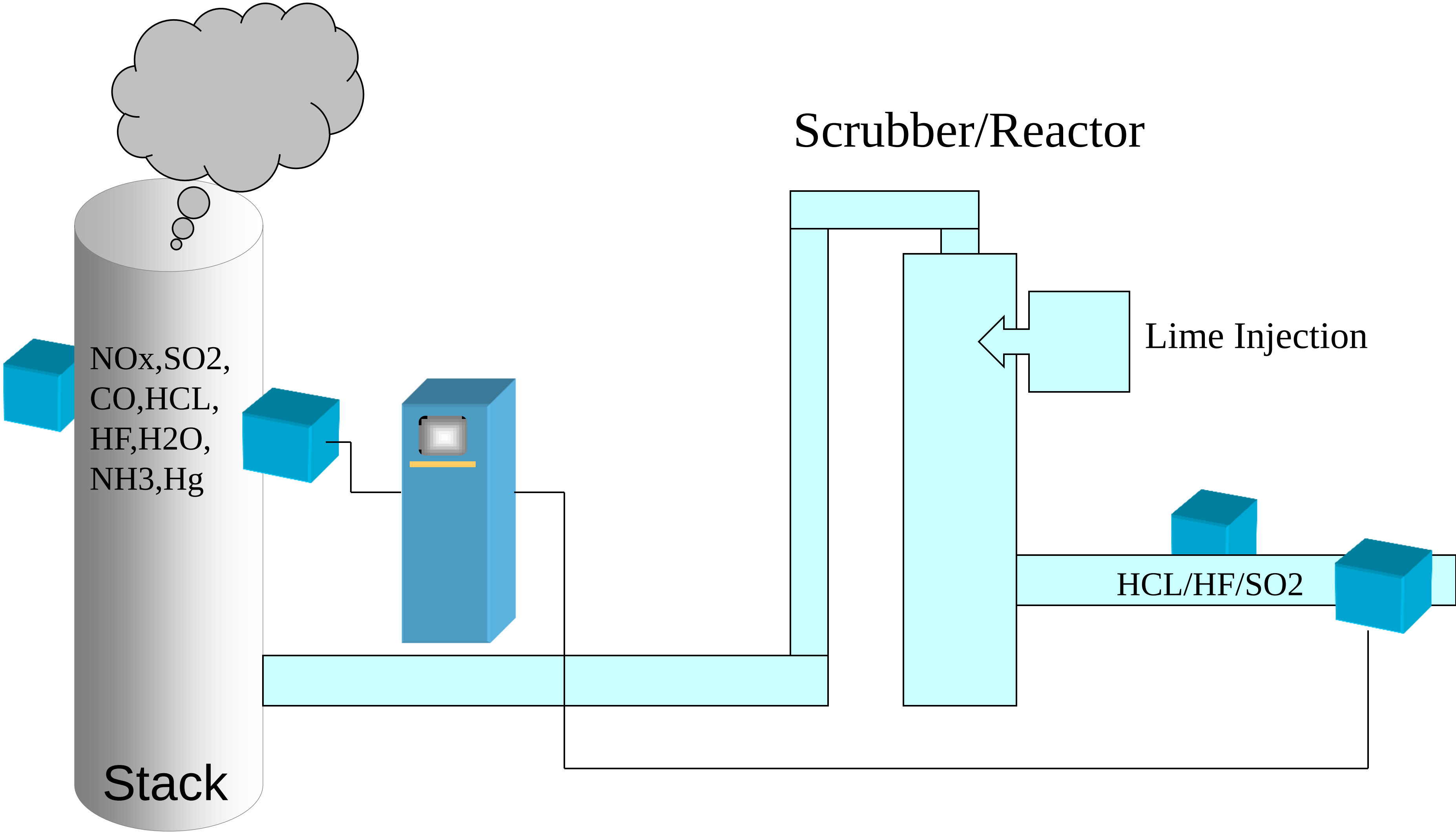
Cement manufacturing process

CEM information



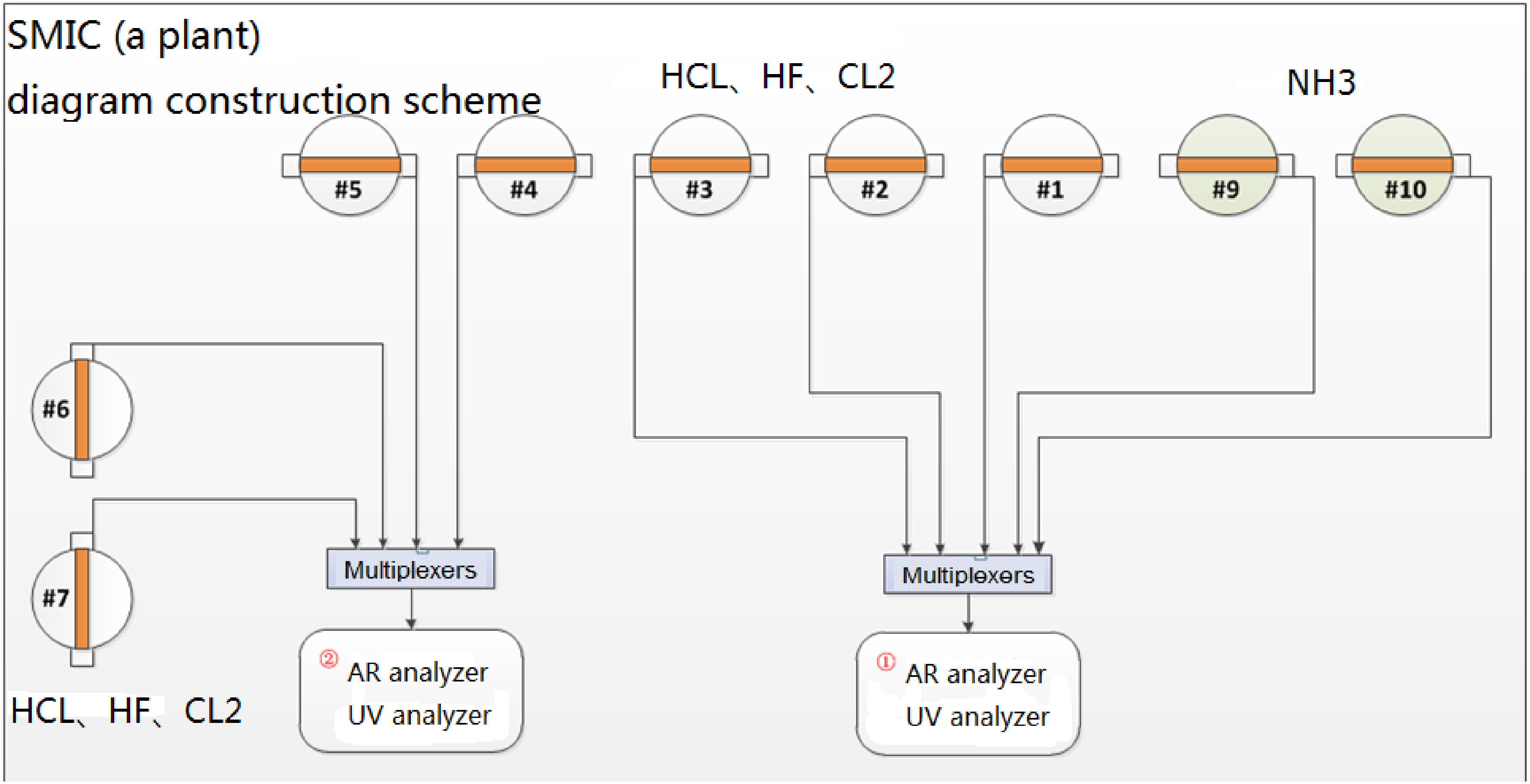
Feedback to Process

SCRUBBER / REACTOR CONTROL



CEM + Process control

MULTIPLE STACK MONITORING OF NH3,CL2,HCL AND HF AT SEMICONDUCTOR PLANT IN CHINA



9 STACKS MONITORED BY TWO OPSIS SYS400

PICTURES FROM SITE

Station 1#

Station 2#

The Stacks

PICTURES FROM SITE

Emitter

Receiver

The Measurement Data

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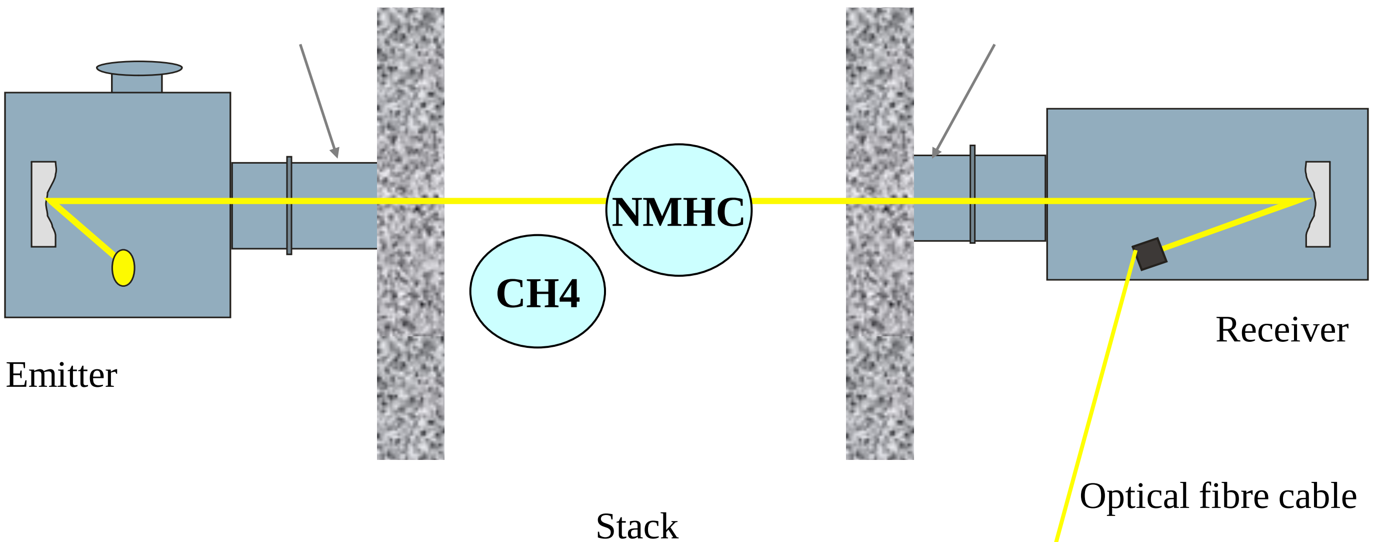
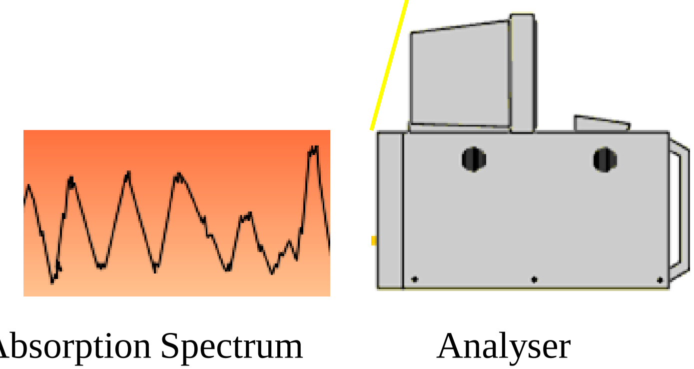
MONITORING THC AND VOC´S



The DOAS system can measure common absorption lines from Non Methane Hydrocarbons as well as Methane, resulting in THC, which can replace expensive and maintenance intensive FID analysers.



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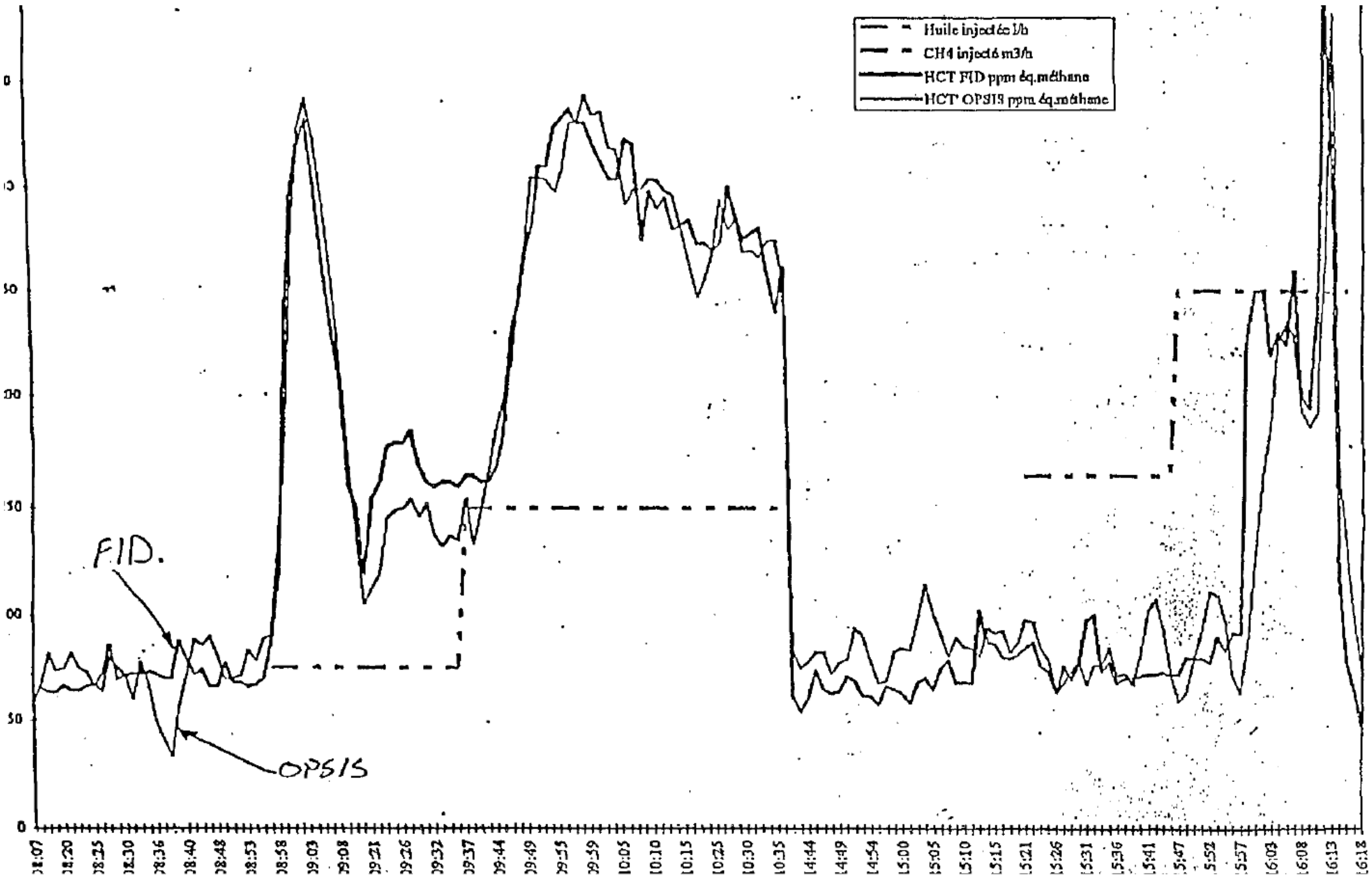
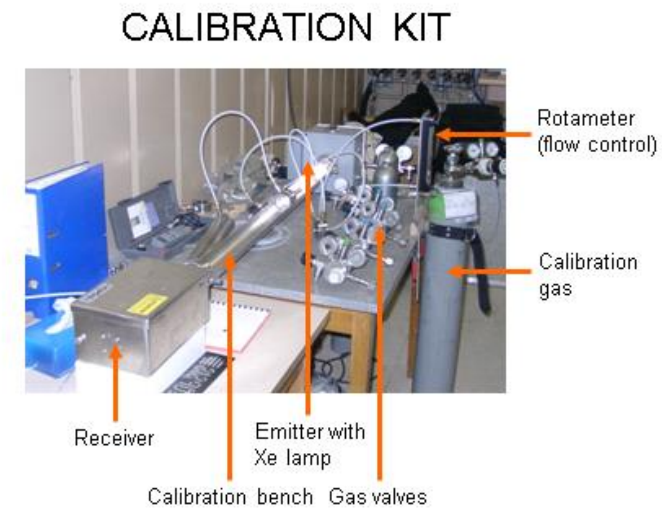
THC COMPARISON FID VS DOAS



CALIBRATION OF TOXIC AND REACTIVE GASES



Opsis standard calibration kit can be used

Some gases requires a gas generator such as HgCL2 for HgTOT and HF , as they are not stable in gas cylinders

Higher concentrations and shorter cells will elimanate problems related to reactive gases

Closed cells with liquid/vapor can be used for some toxic gases such as Hg^0

CALIBRATION OF DOAS SYSTEMS

$$(C_p \times L_p = C_c \times L_c)$$

Example:	100 ppm	x	2 m	=	1000 ppm	x	0.2 m

"Optical density"

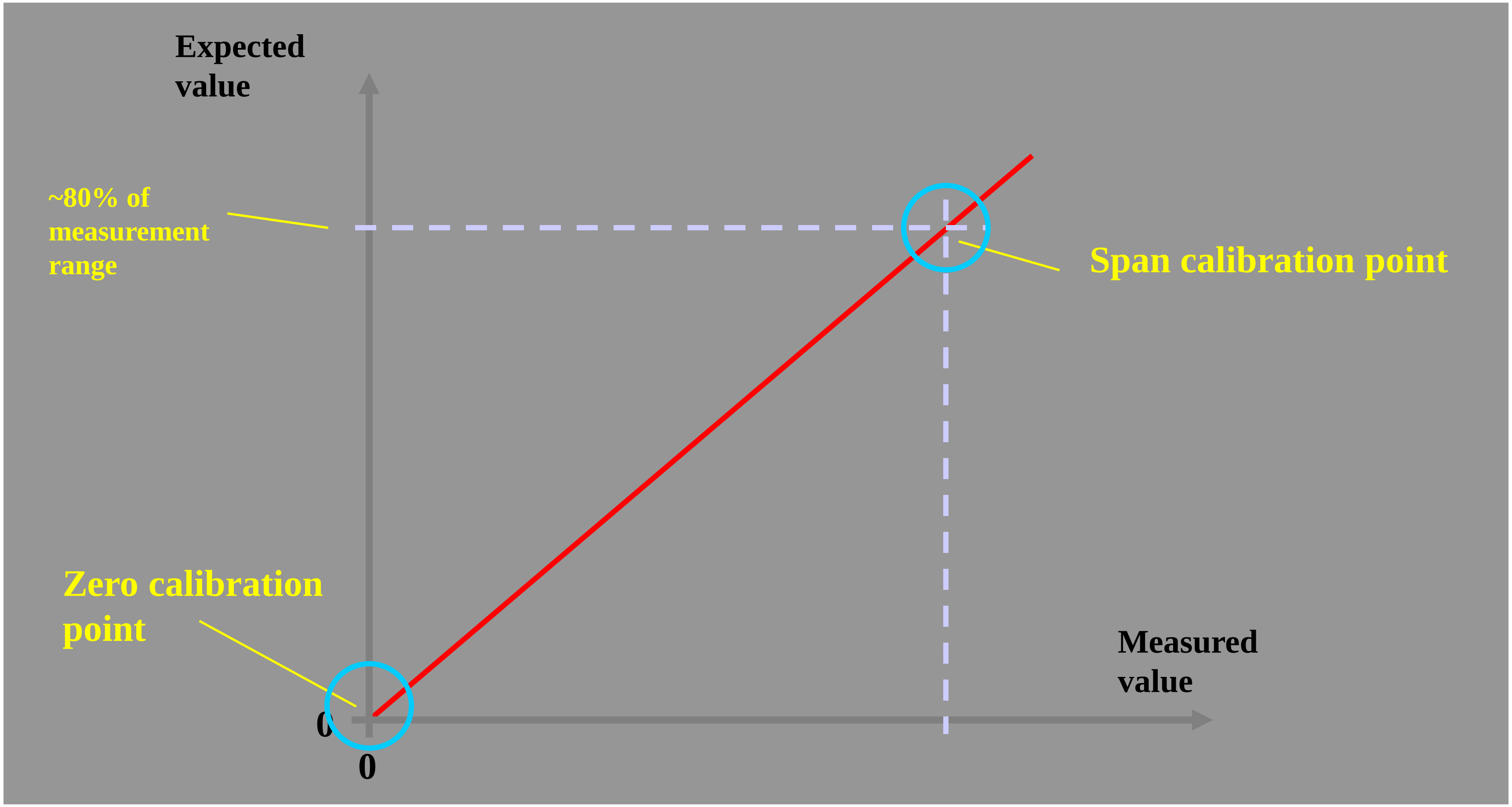
C_p= Concentration in the measuring path

L_p= Length of the measuring path(/diameter)

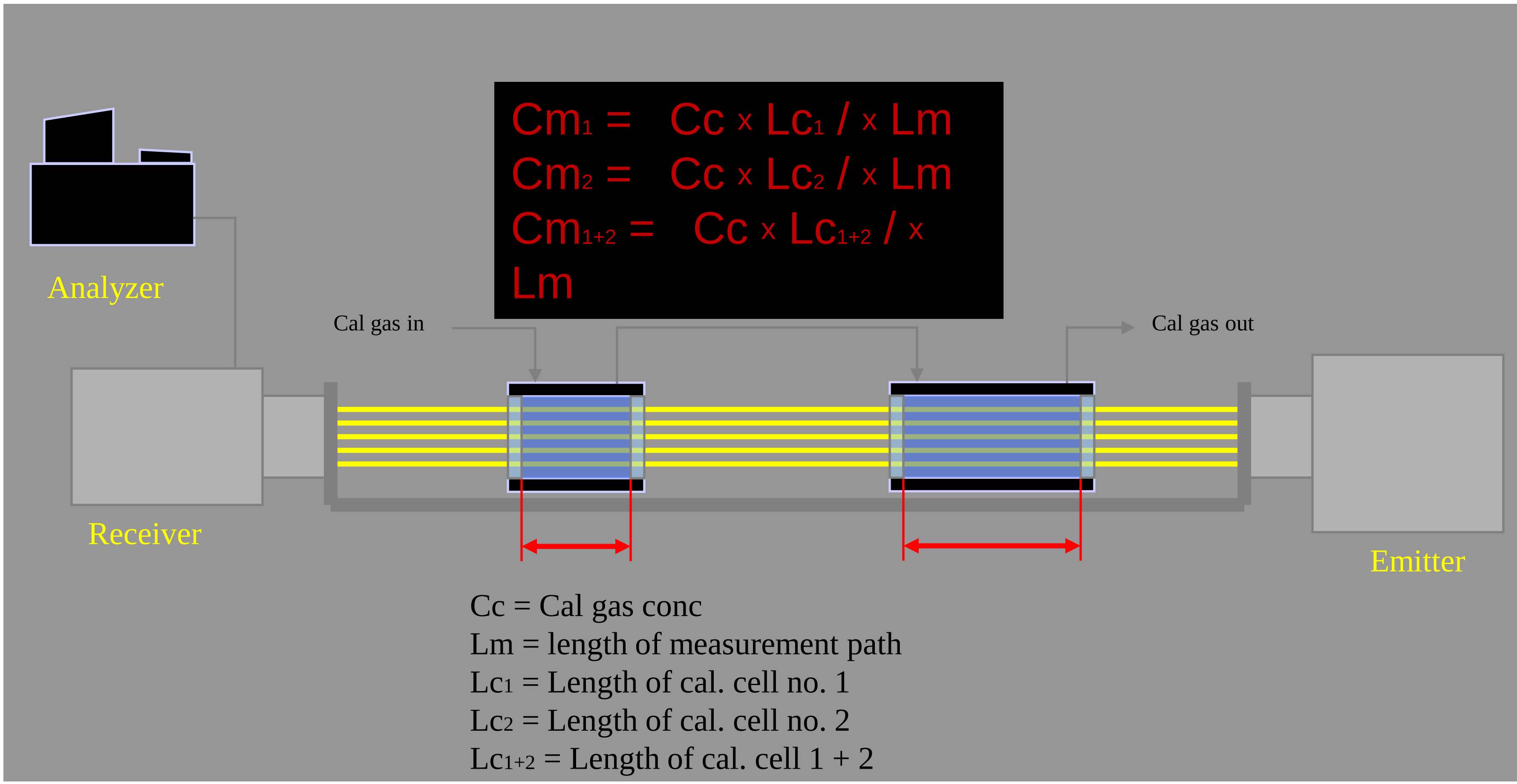
C_c= Concentration in the cell (=gasbottle)

L_c= Length of the Calibration Cell

ZERO AND SPAN CALIBRATION



MULTIPOINT/LINEARITY CALIBRATION



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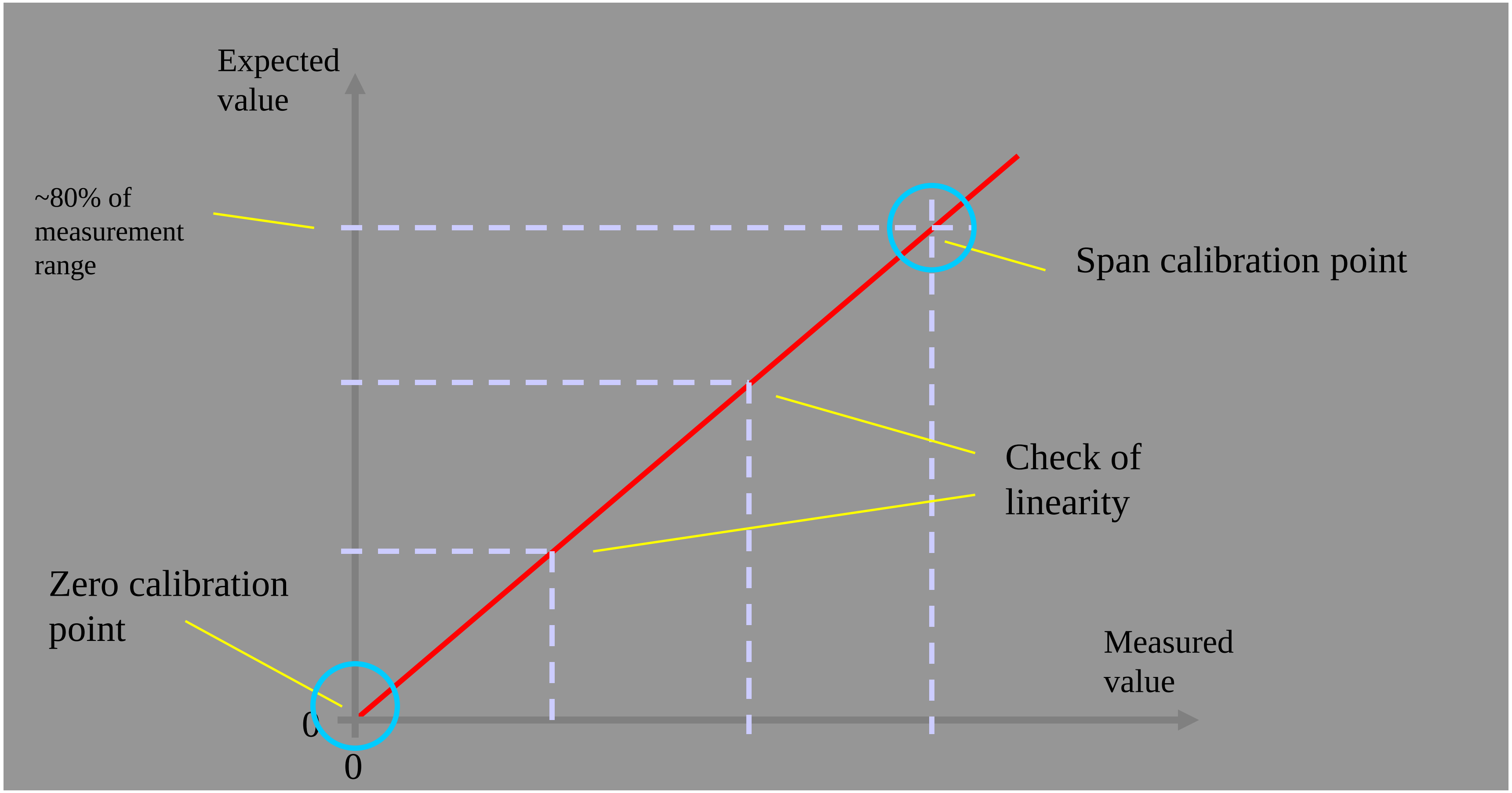
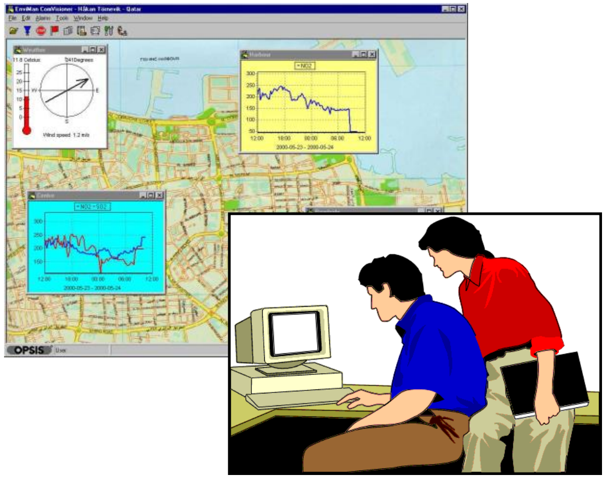


OTHER MONITORING SOLUTIONS

Complete AQM stations

www.opsis.se

Data presentation and reporting



Dust / PM10/PM2.5

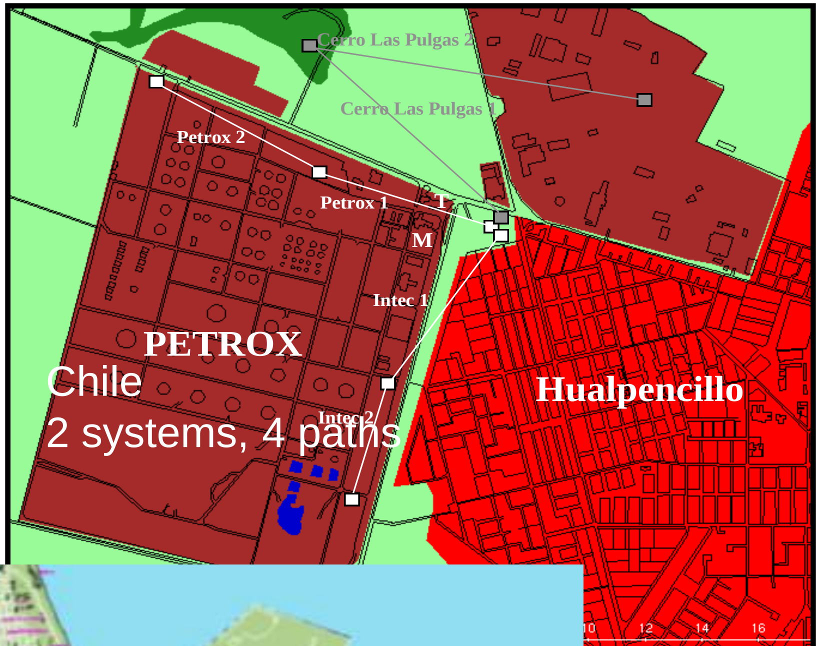
Metereological masts

DOAS open path system

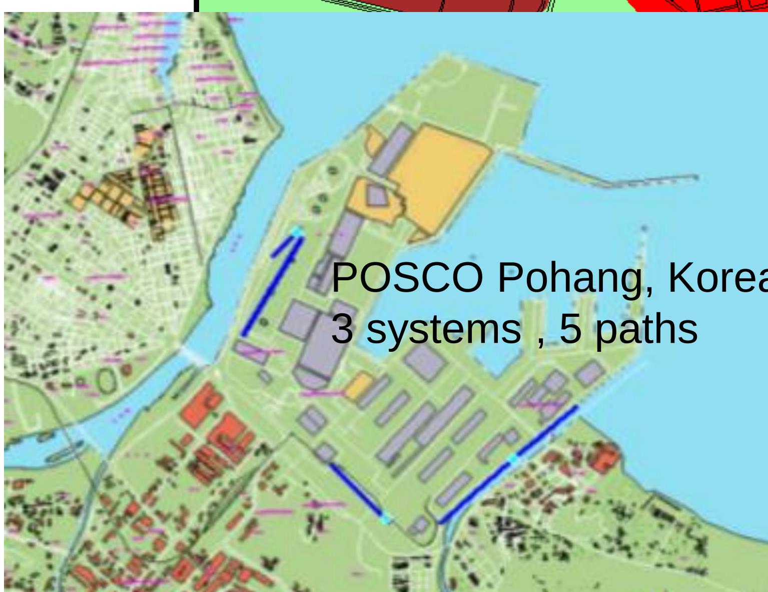
Public information

FENCE-LINE MONITORING OF FUGITIVE EMISSIONS IN INDUSTRIAL AREAS

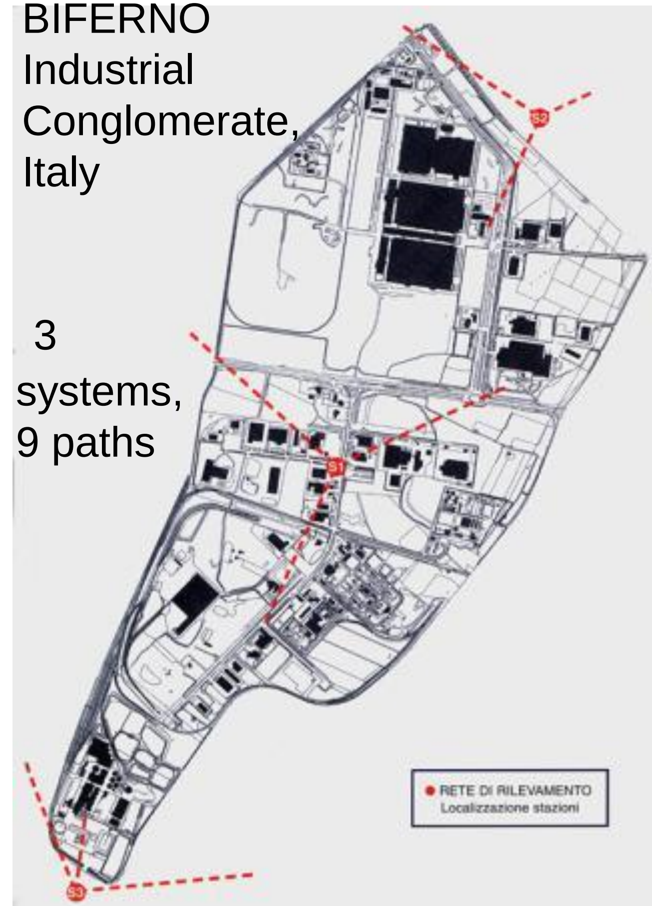
FENCE LINE MONITORING SOLUTIONS



Chile
2 systems, 4 paths



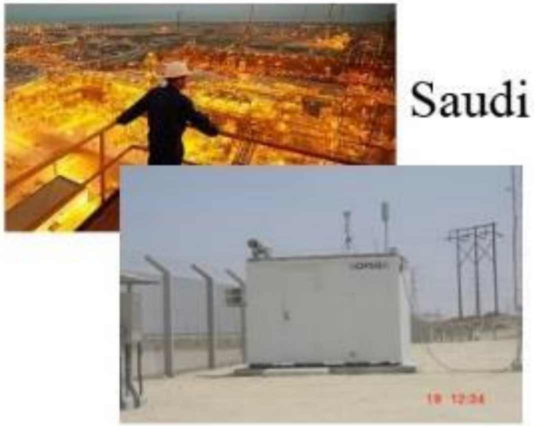
POSCO Pohang, Korea
3 systems , 5 paths



BIFERNO
Industrial
Conglomerate,
Italy

3
systems,
9 paths

WORLDWIDE OPSIS FENCELINE SYSTEMS

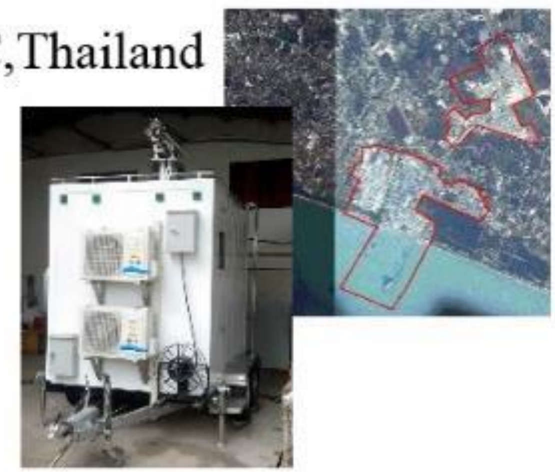


Saudi Aramco

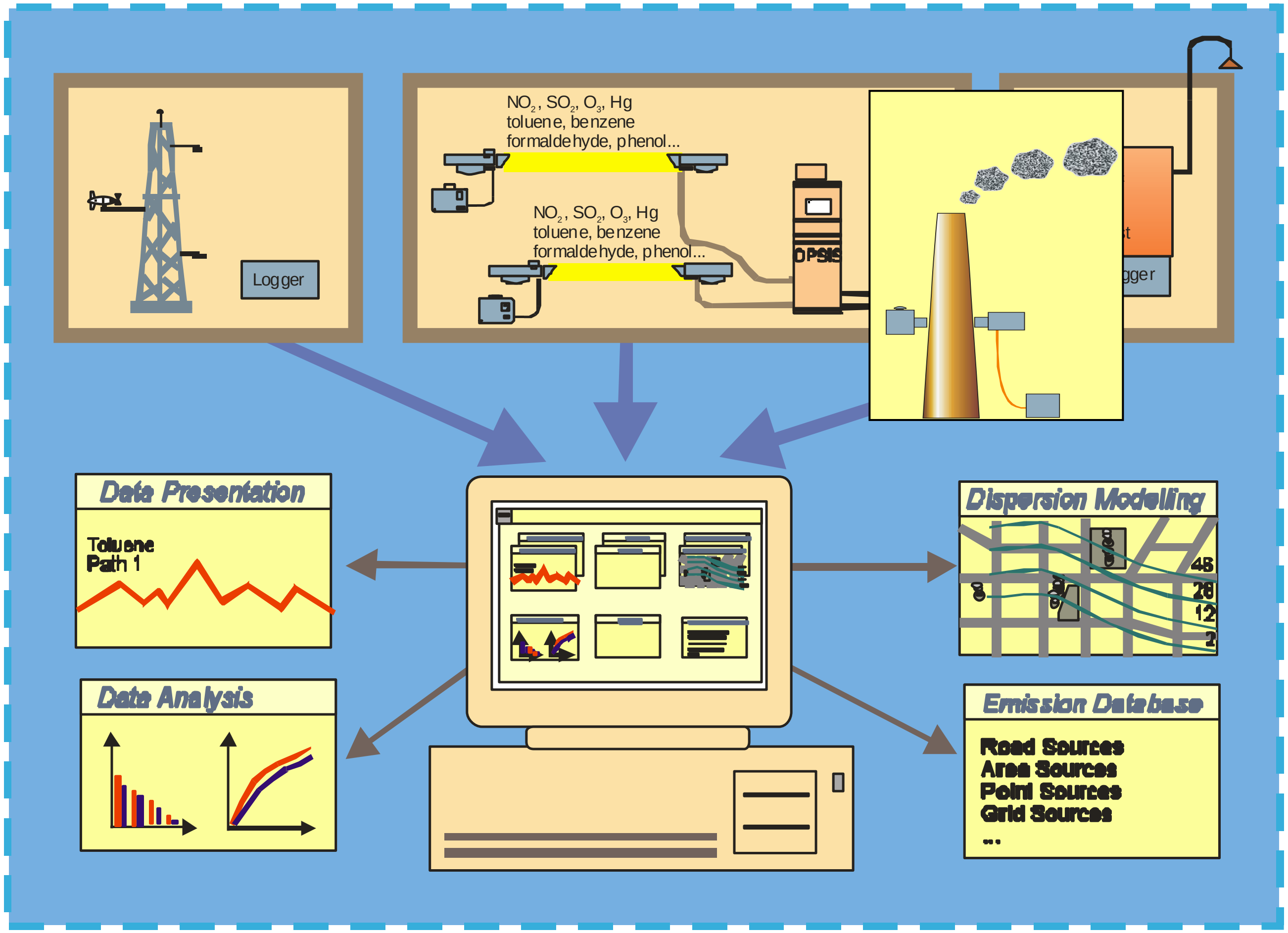
Porto Marghera ,Italy

BP,Belgium

IRPC,Thailand



TOTAL MONITORING AND MANAGEMENT SOLUTION FOR INDUSTRIES



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Thank you for your attention!