Continous Emission Monitoring:

Methods, Regulations and QA/QC

Anders Arvidsson, Opsis AB, Sweden

OPSIS?

OPSIS is a Swedish company which develops, manufactures and supplies total solutions for Ambient Air Quality Monitoring, Stack Emission Monitoring and software tools for Air Quality Management.

Founded 1985

OPSIS is represented world-wide, with internationally accepted and approved products.

TÜV Rheinland

mCERTS
THE ENVIRONMENT AGENCY'S MONITORING CERTIFICATION SCHEME

ISO 17025

- Accredited Calibration laboratory

EPA United States Environmental Protection Agency

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

OPSIS

AIR QUALITY MONITORING

Street

Mobile

City

Background

Industries

Airports

CONTINUOUS EMISSION MONITORING

Power

Waste Incineration

Cement

Steel plants

Chemical Industries

Ship Emissions

Sulfuric Acid plants

OPSIS

CEM PRODUCTS

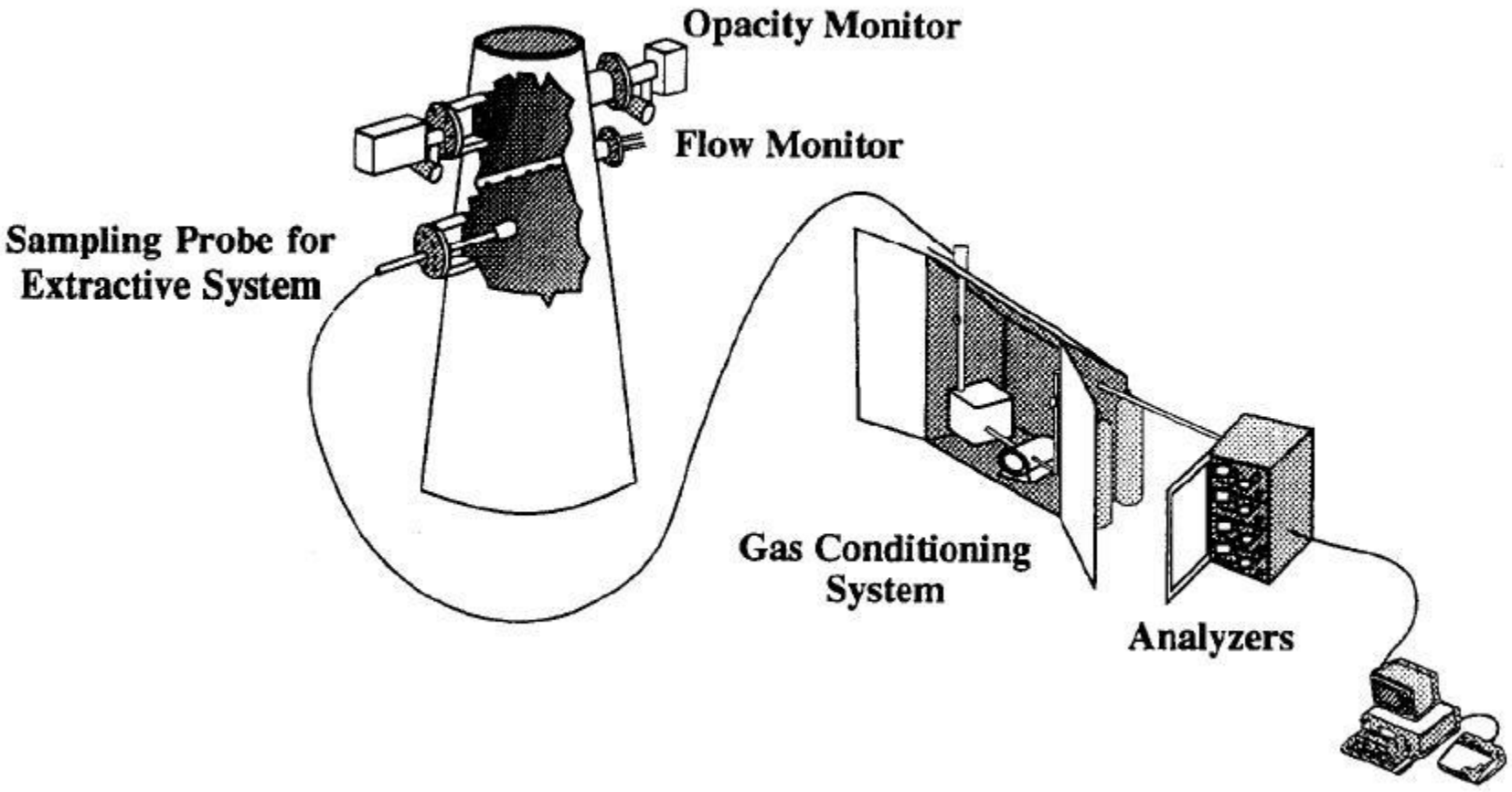
Methods

- In Situ
- Dilution extractive
- Wet-hot extractive
- Dry extractive

Techniques

- DOAS
- FTIR
- IR absorption
- UV absorption
- Chemiluminescence
- UV-fluorescence
- Gas cell
- and more….

A TYPICAL EXTRACTIVE CEMS



EXTRACTIVE METHODS

Dilution extractive	+ Ambient type analysers can be used + Sample is dry and clean + Low initial cost - Requires correct dilution - Not suitable for monitoring low concentrations
Wet-hot extractive	+ Multigas analysers can be used - Expensive - Hot sample requires advanced heating systems - Sensitive for power failures and high dust loads
Dry extractive	+ Low cost NDIR analysers can be used - Not suitable with high dust loads - Water removal changes the sample condition

IN-SITU CEMS

Cross Stack

+Non-contact measurements
+No sample system
+Cross stack = representative measurements
+Analyser can be installed in cool and dry environment
-Requires extended platforms

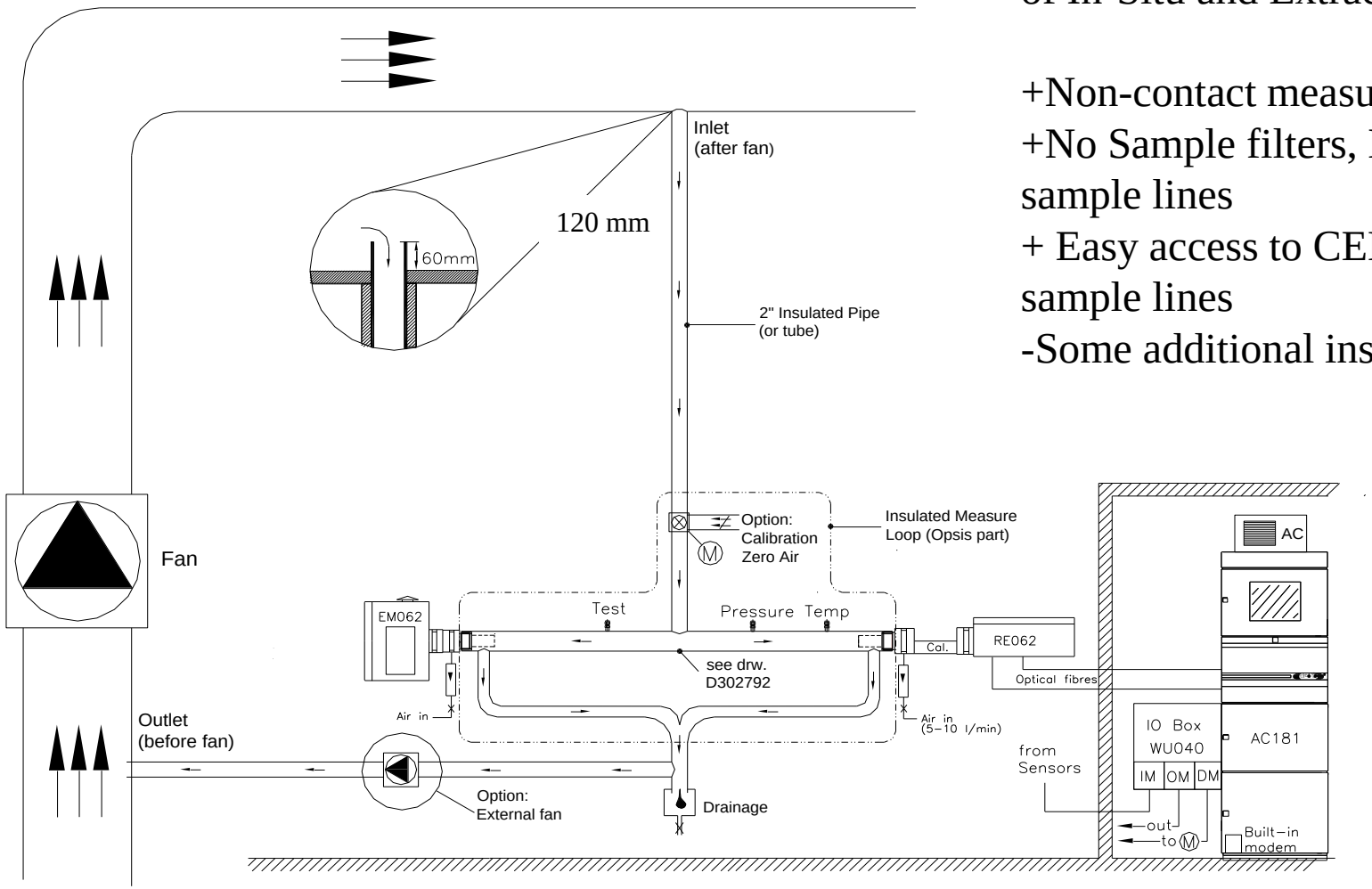
Probe Type

+No sample system
+Partly non-contact measurements
-Probe exposed for flue gas
-Analyser exposed for rain,humidity, sun radiation etc

IN-SITU EXTRACTIVE ?

Fast Loop Solution, a combination of In-Situ and Extractive

+Non-contact measurements
+No Sample filters, No heated sample lines
+ Easy access to CEM system sample lines
-Some additional installation costs



FASTLOOP INSTALLATION

WHY CONTINOUS EMISSION MONITORING ?

- **Regulations** (Examples)
  - E.U 2001/80/EC (LCPD) (NOx, SO2, CO)
  - US 40 CFR Part 60 / 75
  - Emissions trading programs, for example:
    - European emission trading scheme (greenhouse gases)
    - Acid rain program (U.S)
  - Emission Fees and Taxes
  - Local Regulations in Thailand ?

- **Cost saving, process applications**

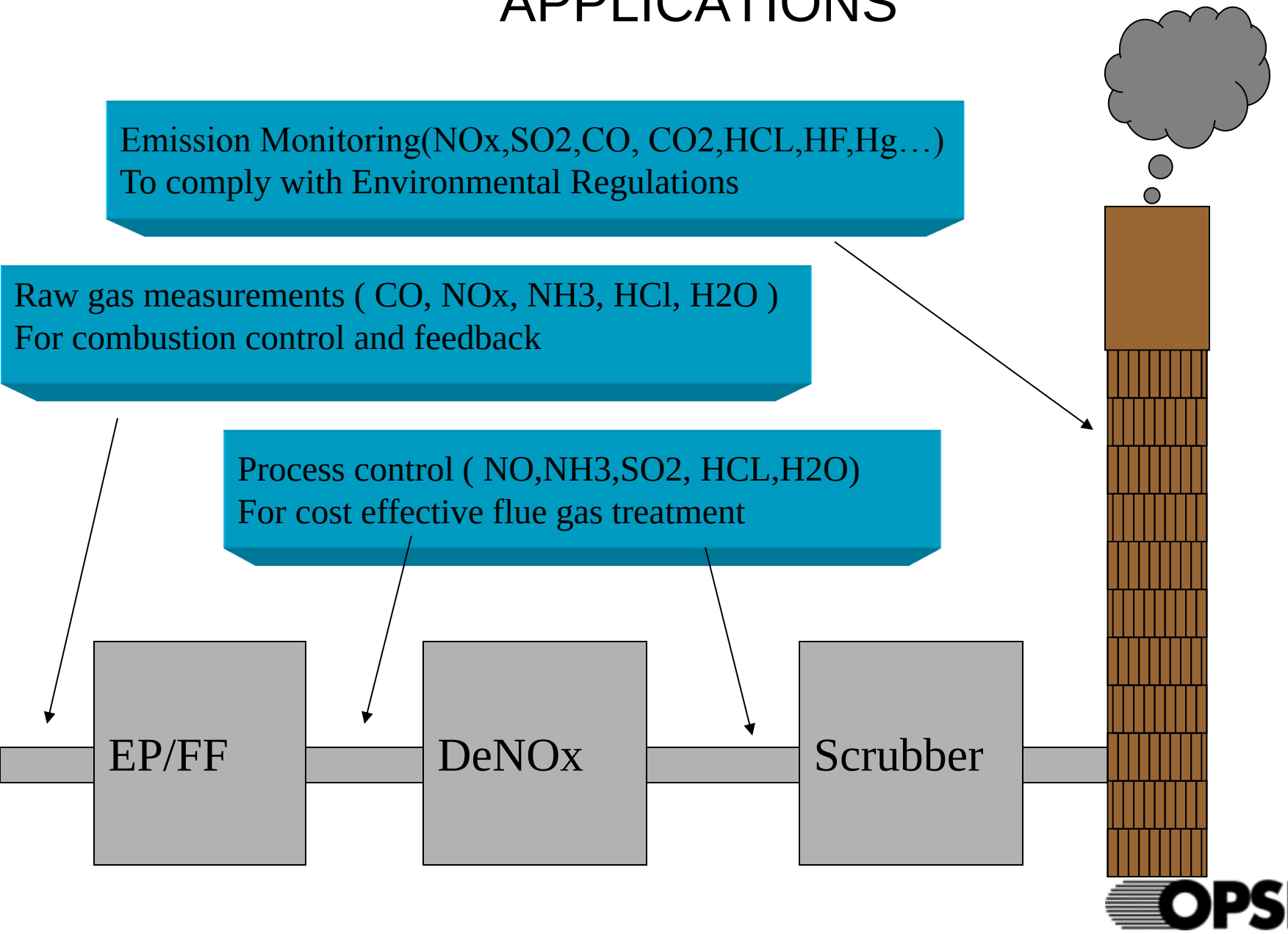
(DeSOx,DeNOx, Scrubbers , combustion control)

APPLICATIONS

Emission Monitoring(NOx,SO2,CO, CO2,HCL,HF,Hg…)
To comply with Environmental Regulations

Raw gas measurements (CO, NOx, NH3, HCl, H2O)
For combustion control and feedback

Process control (NO,NH3,SO2, HCL,H2O)
For cost effective flue gas treatment



EUROPEAN REGULATION

2001-80-EC (and others) -Which Industries, Which pollutants and Limit Values

EN14181- Quality Assurance of CEM systems

EN15267- type approval /eqvivalent methods

EN 14181

QAL1 - Each CEM system must have certificate from accredited body (TÜV etc) showing if the CEM system meets the required performance specifications

QAL2 – Field comparison with accredited testing laboratory/reference methods (at installation and then every 5 years)

QAL3- The maintenance requirements and frequency

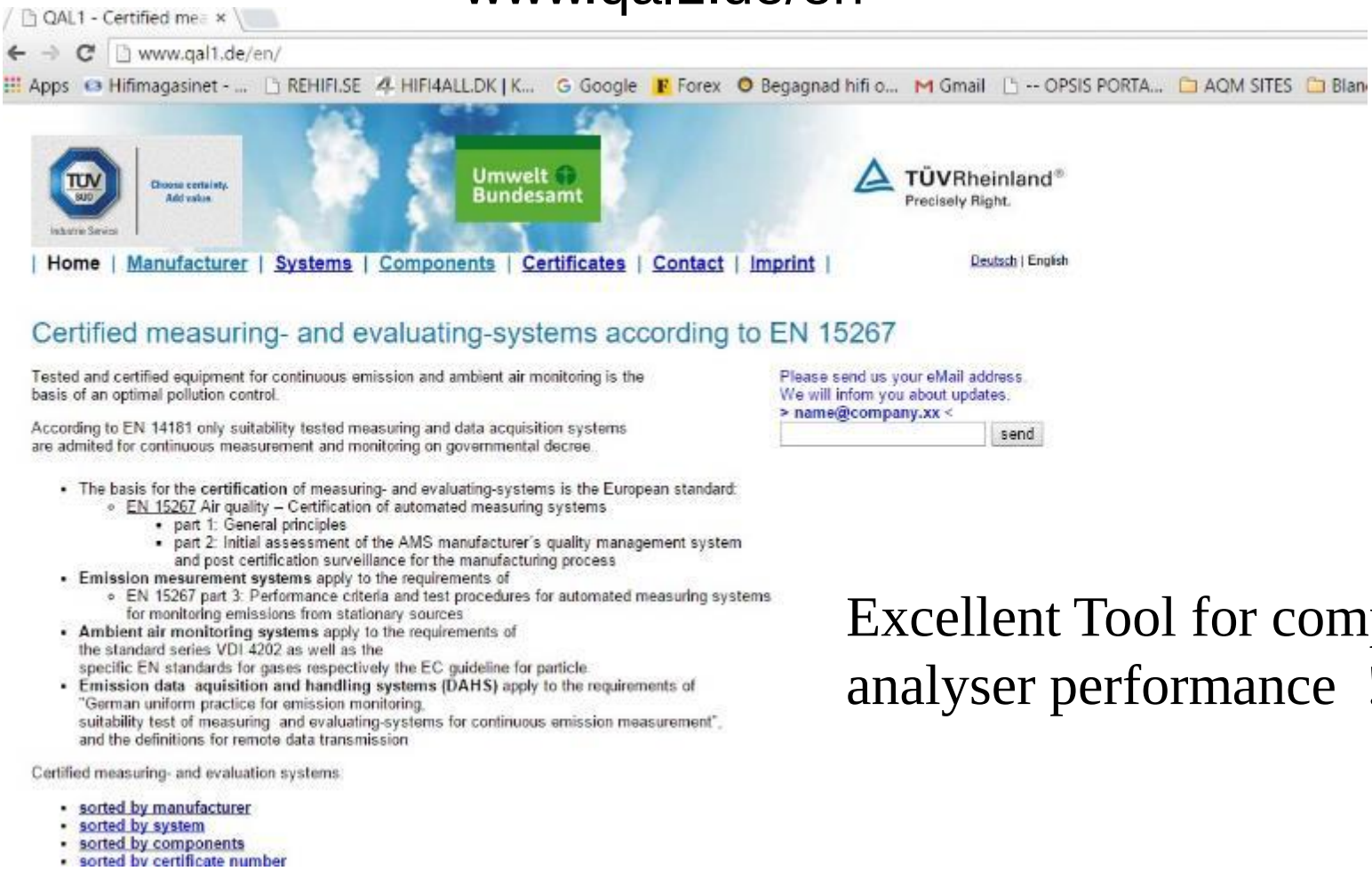
AST – same as QAL2, but at a smaller scale and every 12 months

HOW TO BUY A CEM SYSTEM THAT MEETS YOUR REQUIREMENTS

(CAN YOU TRUST THE SALES PERSON ?)

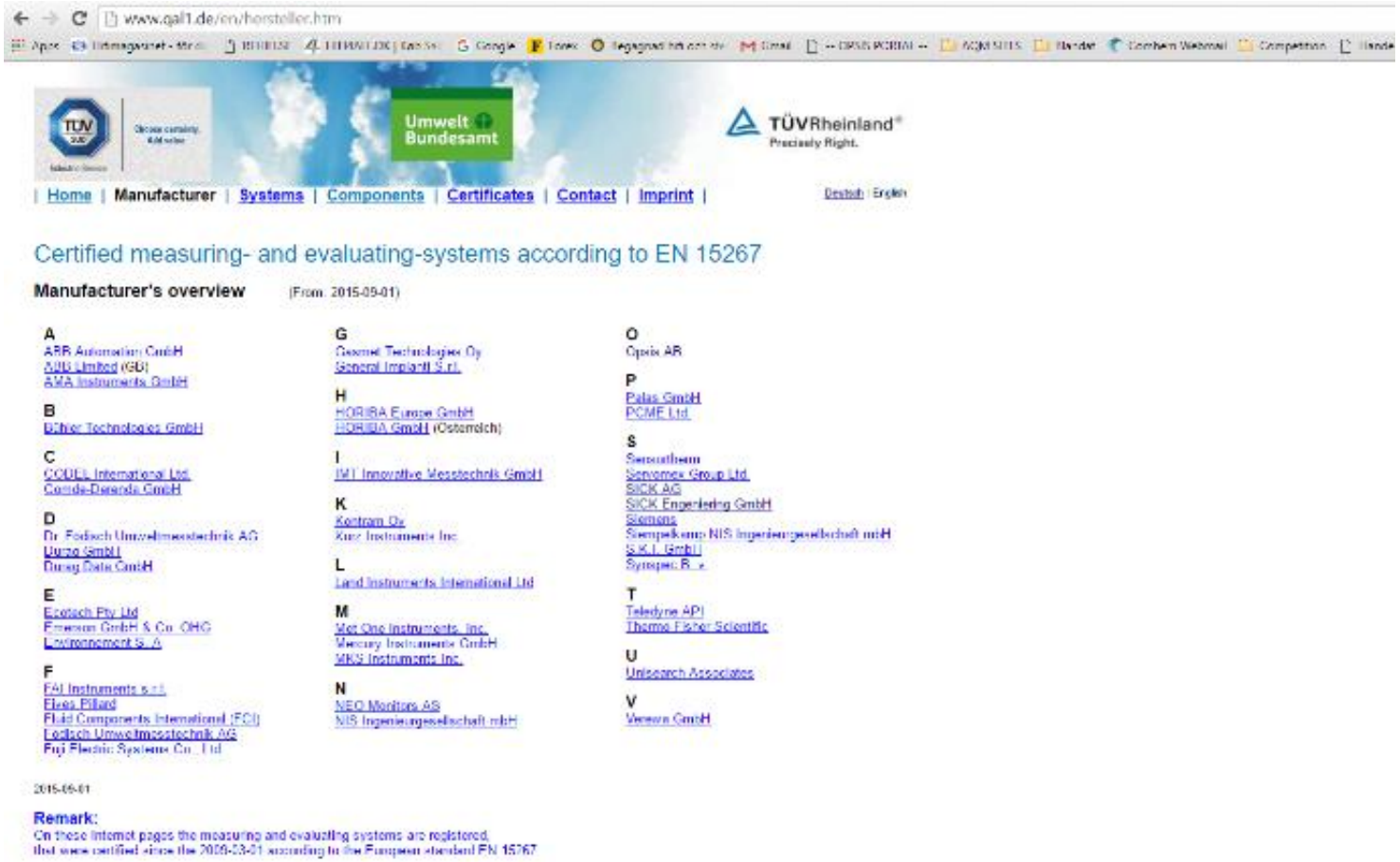
TÜV CERTIFICATIONS WEBPAGE

www.qal1.de/en



Excellent Tool for comparing analyser performance !

LIST OF CERTIFIED MANUFACTURERS



www.qal1.de/en/hersteller.htm

Umwelt Bundesamt

TÜVRheinland® Precisely Right.

Home | Manufacturer | Systems | Components | Certificates | Contact | Imprint | Deutsch | English

Certified measuring- and evaluating-systems according to EN 15267

Manufacturer's overview (From: 2015-09-01)

A
ABB Automation GmbH
AMS Limited (GB)
AMA Instruments GmbH

B
Bühler Technologies GmbH

C
CODEL International Ltd.
Comde-Derenda GmbH

D
Dr. Födisch Umweltmesstechnik AG
Durag GmbH
Durag Data GmbH

E
Ecotech Pty Ltd
Environnement S. A.

F
FAI Instruments s.r.l.
Fluid Components International (FCI)
Födisch Umweltmesstechnik AG
Fuji Electric Systems Co., Ltd

G
Gasmet Technologies Oy
General Impianti S.r.l.

H
HORIBA Europe GmbH
HORIBA GmbH (Österreich)

I
IMI Innovative Messtechnik GmbH

K
Kantsen Oy
Kurz Instruments Inc.

L
Land Instruments International Ltd

M
Met One Instruments, Inc.
Mercury Instruments GmbH
MKS Instruments Inc.

N
NEO Monitors AS
NIS Ingenieurgesellschaft mbH

O
Opsis AB

P
Palas GmbH
PCME Ltd.

S
Sensotherm
Sensorex Group Ltd.
SICK AG
SICK Engelberg GmbH
Siemens
Siemplelkamp NIS Ingenieurgesellschaft mbH
S.K.I. GmbH
Synspec B. v.

T
Teledyne API
Thermo Fisher Scientific

U
Unisearch Associates

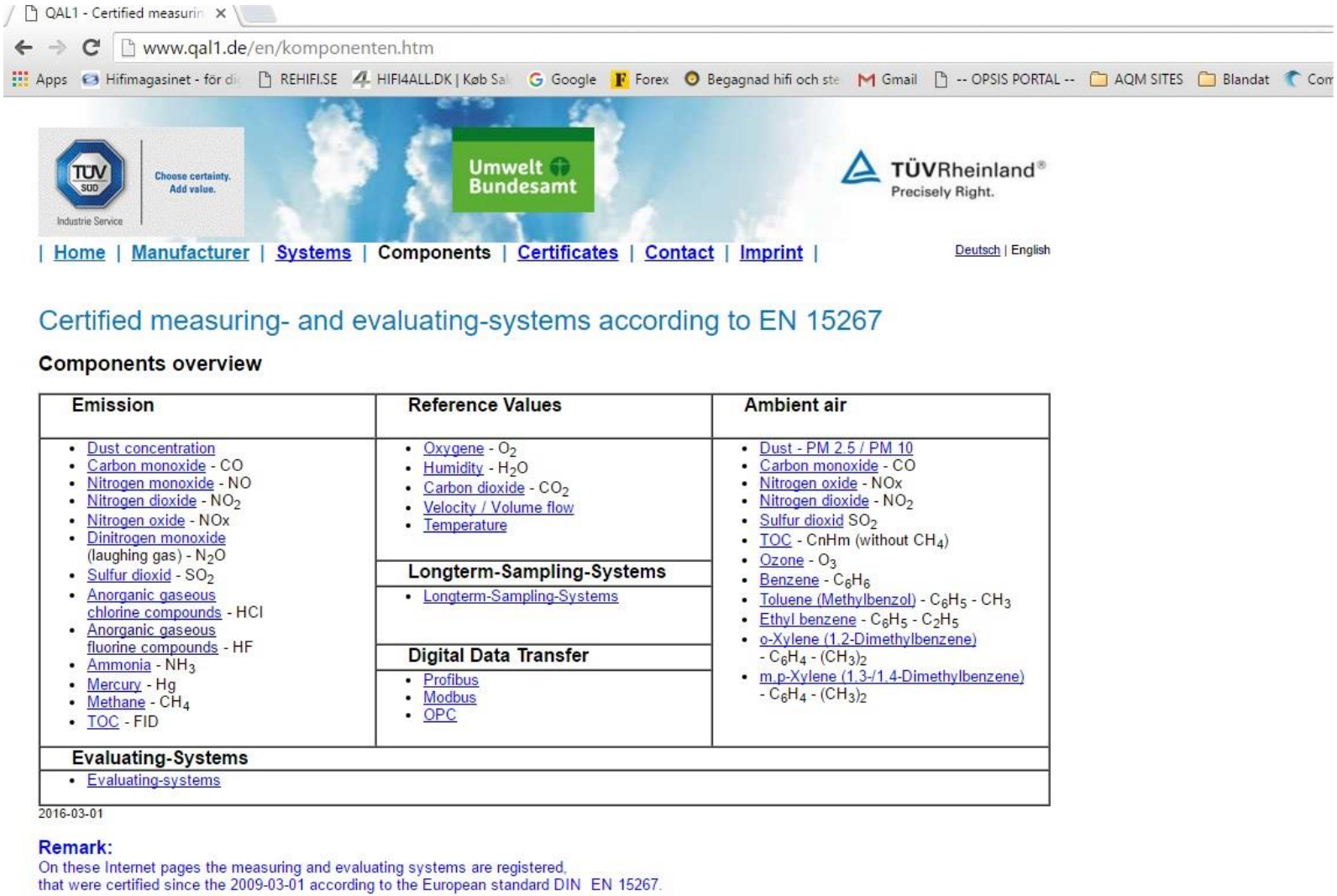
V
Vereva GmbH

2015-09-01

Remark:
On these internet pages the measuring and evaluating systems are registered, that were certified since the 2009-03-01 according to the European standard EN 15267.

OPSIS

LIST OF GASES



QAL1 - Certified measurin

www.qal1.de/en/komponenten.htm

Apps | Hifimagasinet - för di | REHIFI.SE | HIFI4ALL.DK | Køb Sal | Google | Forex | Begagnad hifi och ste | Gmail | -- OPSIS PORTAL -- | AQM SITES | Blandat | Com

TÜV SÜD Industrie Service — Choose certainty. Add value.

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Deutsch | English

Certified measuring- and evaluating-systems according to EN 15267

Components overview

Emission	Reference Values	Ambient air
• Dust concentration • Carbon monoxide - CO • Nitrogen monoxide - NO • Nitrogen dioxide - NO_2 • Nitrogen oxide - NOx • Dinitrogen monoxide (laughing gas) - N_2O • Sulfur dioxid - SO_2 • Anorganic gaseous chlorine compounds - HCl • Anorganic gaseous fluorine compounds - HF • Ammonia - NH_3 • Mercury - Hg • Methane - CH_4 • TOC - FID	• Oxygene - O_2 • Humidity - H_2O • Carbon dioxide - CO_2 • Velocity / Volume flow • Temperature **Longterm-Sampling-Systems** • Longterm-Sampling-Systems **Digital Data Transfer** • Profibus • Modbus • OPC	• Dust - PM 2.5 / PM 10 • Carbon monoxide - CO • Nitrogen oxide - NOx • Nitrogen dioxide - NO_2 • Sulfur dioxid SO_2 • TOC - CnHm (without CH_4) • Ozone - O_3 • Benzene - C_6H_6 • Toluene (Methylbenzol) - C_6H_5 - CH_3 • Ethyl benzene - C_6H_5 - C_2H_5 • o-Xylene (1.2-Dimethylbenzene) - C_6H_4 - $(CH_3)_2$ • m.p-Xylene (1.3-/1.4-Dimethylbenzene) - C_6H_4 - $(CH_3)_2$
Evaluating-Systems • Evaluating-systems		

2016-03-01

Remark:
On these Internet pages the measuring and evaluating systems are registered,
that were certified since the 2009-03-01 according to the European standard DIN EN 15267.

OPSIS

COMPARISON BASED ON TÜV QAL1

Based on Total Uncertainty

Parameter	Measure-ment Level	OPSIS	SICK	Gasmet	ABB	Limit
SO_2	50 mg/m³	4.9%	10.5%	9.4%	10.0%	15%
NO_2	20 mg/m³	4.7%	37.1%	57.0%	–	15%
NO	131 mg/m³	2.8%	9.5%	6.5%	8.2%	15%
NH_3	10 mg/m³	5.0%	6.4%	9.6%	–	30%
CO	50 mg/m³	5.4%	8.7%	6.0%	9.8%	7.5%
H_2O	30% Vol.	4.0%	5.7%	6.2%	4.2%	7.5%
HCl	10 mg/m³	6.2%	12.2%	12.0%	11.8%	30%
HF	1 mg/m³	18.4%	30.3%	18.4%	63.0%	30%
O_2	25% Vol.	4.8%	2.8%	2.4%	2.4%	7.5%
Hg^{tot}	30 µg/m³	7.8%	2.3%	–	–	30%
CH_4	20 mg/m³	5.4%	15.6%	–	–	22.5%
CO_2	30% Vol.	2.3%	6.7%	5.0%	–	7.5%

THE IMPORTANCE OF GOOD PERFORMANCE

Good performance is important when money is involved.

- CO_2 measurements for tax reasons.
- NO and NO_2 measurements for NO_x limits and NO_x tax.
- SO_2 measurements for ship regulation.

Good performance is important in order to pass QAL2/AST or RATA

New regulation going towards lower emissions, requires analysers with better performance

QAL 1 CERTIFICATES

DAP-PL-3856.99

TÜV

CERTIFICATE

TÜV Rheinland Immissionsschutz und Energiesysteme GmbH

Manufacturer:	Opsis AB
Measuring System:	AR 602 Z UV DOAS
Components:	SO_2, NO, NO_2, NH_3, Hg, H_2O
Test Report:	936/800009, 936/800010, 936/804002/Hg, 936/804002/NH3

The measurement system fulfils
the requirements of
QAL 1
according to EN 14181 and EN ISO 14956.

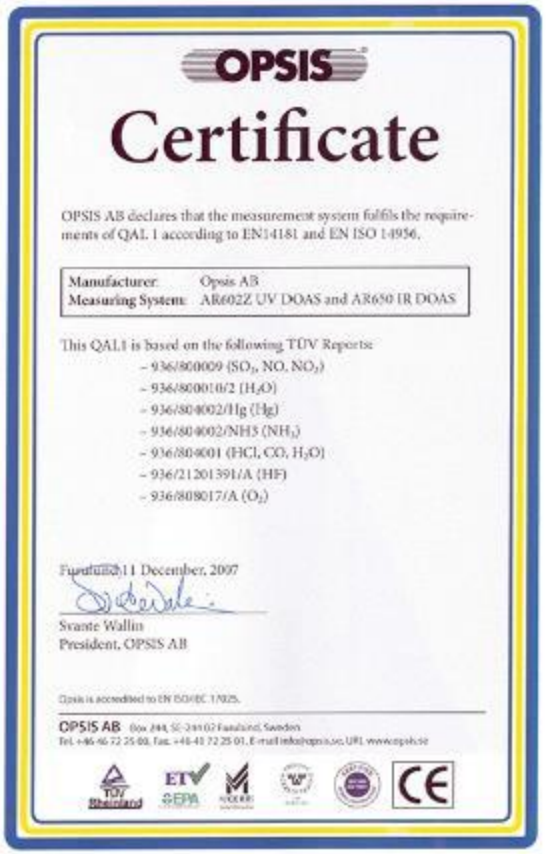
Köln, 2007-12-20 Dr. rer. nat. Peter Wilbring Dipl-Chem. Manfred Kalisa

www.umwelt-tuv.de / www.eco-tuv.com
tte@umwelt-tuv.de
Tel. +49 - 221 - 806 - 2275

TÜV Rheinland Immissionsschutz und Energiesysteme GmbH
Am Grauen Stein
51105 Köln

The company is accredited to DIN EN ISO/IEC 17025.

Abbildung ähnlich



OPSIS

Certificate

OPSIS AB declares that the measurement system fulfils the requirements of QAL 1 according to EN14181 and EN ISO 14956.

Manufacturer:	Opsis AB
Measuring System:	AR602Z UV DOAS and AR650 IR DOAS

This QAL1 is based on the following TÜV Reports:

- 936/800009 (SO_2, NO, NO_2)
- 936/800010/2 (H_2O)
- 936/804002/Hg (Hg)
- 936/804002/NH3 (NH_3)
- 936/804001 (HCl, CO, H_2O)
- 936/21201391/A (HF)
- 936/808017/A (O_2)

Fundåsen, 11 December, 2007

Svante Wallin
President, OPSIS AB

Opsis is accredited to EN ISO/IEC 17025.

OPSIS AB Box 244, SE-244 02 Fundåsen, Sweden
Tel. +46 46 72 25 00, Fax. +46 46 72 25 01, E-mail info@opsis.se, URL www.opsis.se

TÜV Rheinland ETV US-EPA CE

OPSIS

CALIBRATION INTERVAL CONFIRMED BY TÜV

Opsis is the only Manufacturer in the world that has got 12 months calibration interval verified by German TÜV !

TÜV RHEINLAND
ENERGIE UND UMWELT GMBH

DAkkS

Report on additional long term drift investigations
of the continuous measurement system AR602Z/N
of OPSIS AB for NO, NO_2, SO_2 and NH_3

TÜV-Report No.: 936/21228179/B
Cologne, 26 June 2015

www.umwelt-tuv.de

tuv-service@de.tuv.com

The department of Environmental Protection of TÜV Rheinland Energie und Umwelt GmbH
is accredited for the following work areas:

- Determination of air quality and emissions of air pollution and odour substances;
- Inspection of correct installation, function and calibration of continuously operating emission measuring instruments, including data evaluation and remote emission monitoring systems;
- Combustion chamber measurements;
- Performance testing of measuring systems for continuous monitoring of emissions and ambient air, and of electronic data evaluation and remote emission monitoring systems;
- Determination of stack height and air quality projections for hazardous and odour substances;
- Determination of noise and vibration emissions and pollution, determination of sound power levels and execution of sound measurements at wind energy plants

according to EN ISO/IEC 17025.

The accreditation is valid up to 22-01-2018. DAkkS-register number: D-PL-11120-03-00.

Reproduction of extracts from this test report is subject to written consent.

TÜV Rheinland Energie und Umwelt GmbH
D - 51105 Cologne, Am Grauen Stein, Tel: +49 221 806-2765, Fax: +49 221 806-1349

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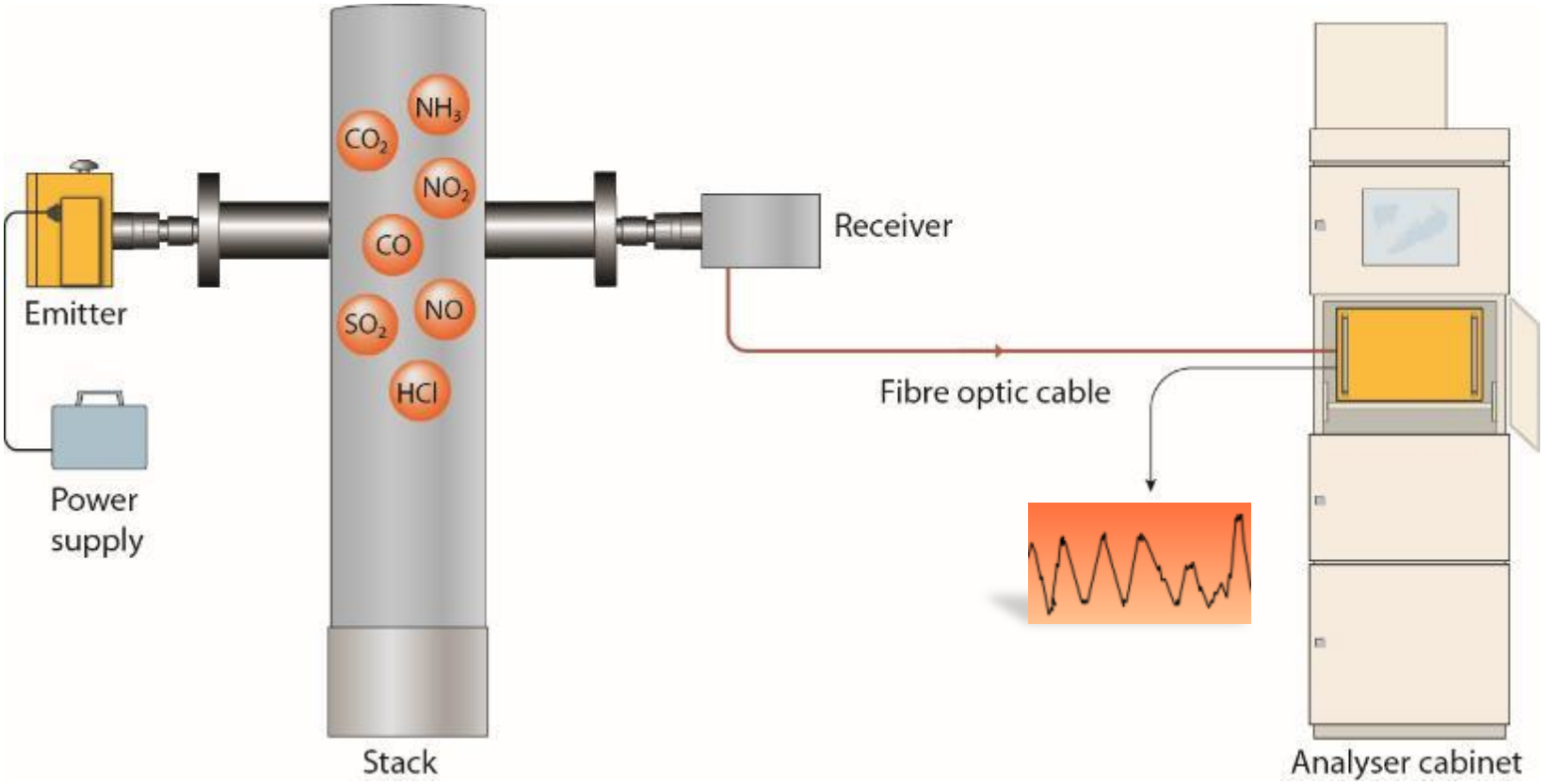
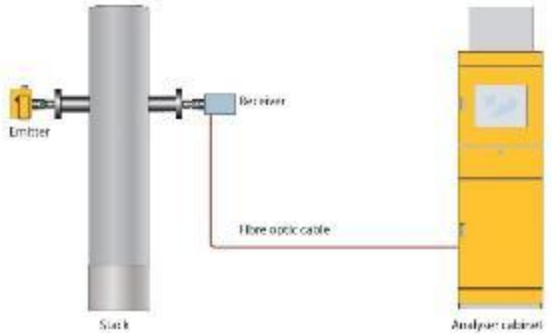
OPSIS DOAS TECHNIQUE

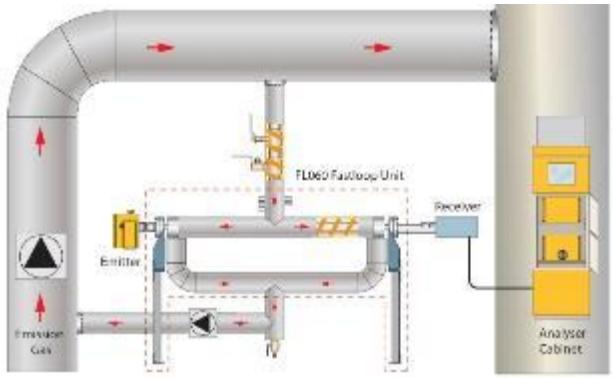


Differential **O**ptical **A**bsorption **S**pectroscopy

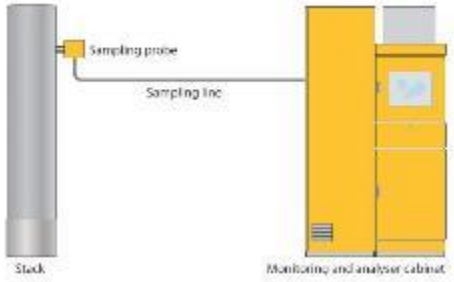
OPSIS CEM SOLUTIONS



Cross-Stack In-Situ (~85%)



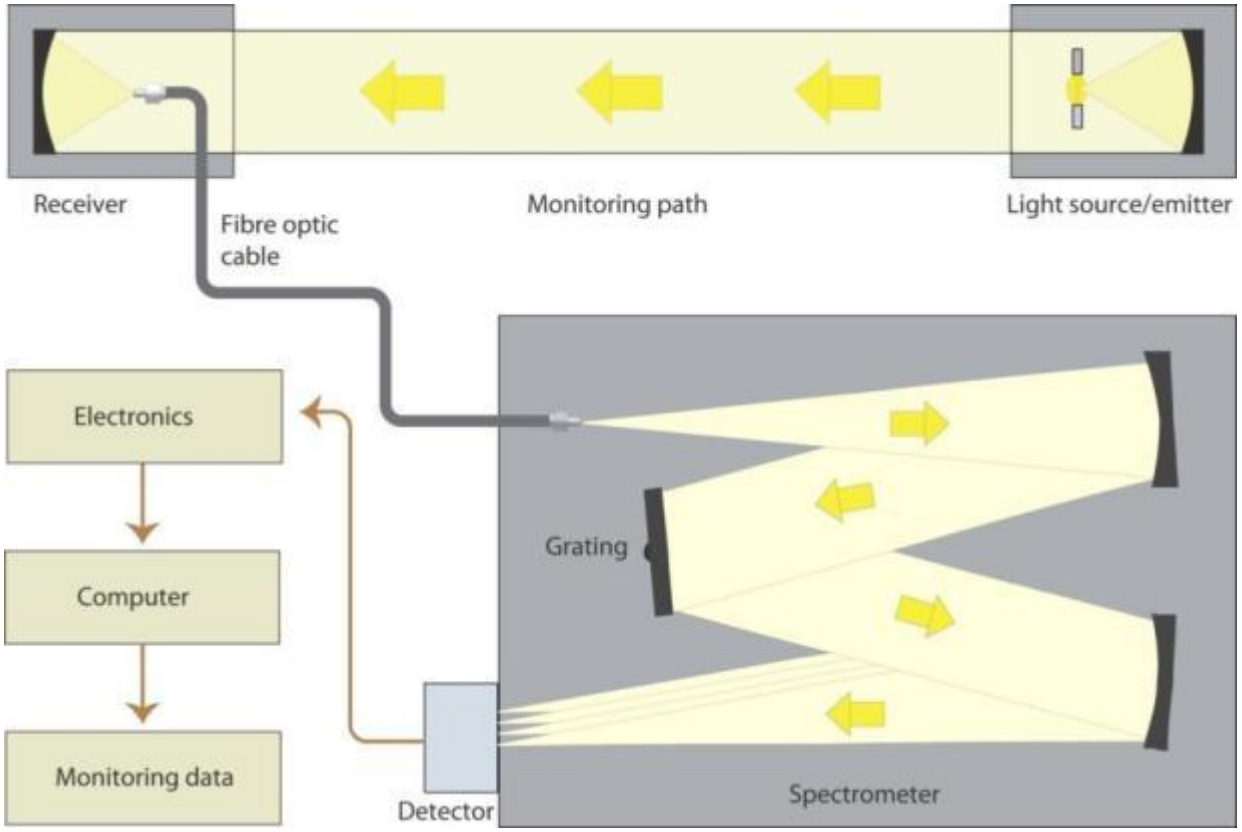
Fast Loop In-Situ (~15%)



Hot/Wet and Dilution Extractive (~5%)

UV DOAS

DOAS= Differential Optical Absorption Spectroscopy)



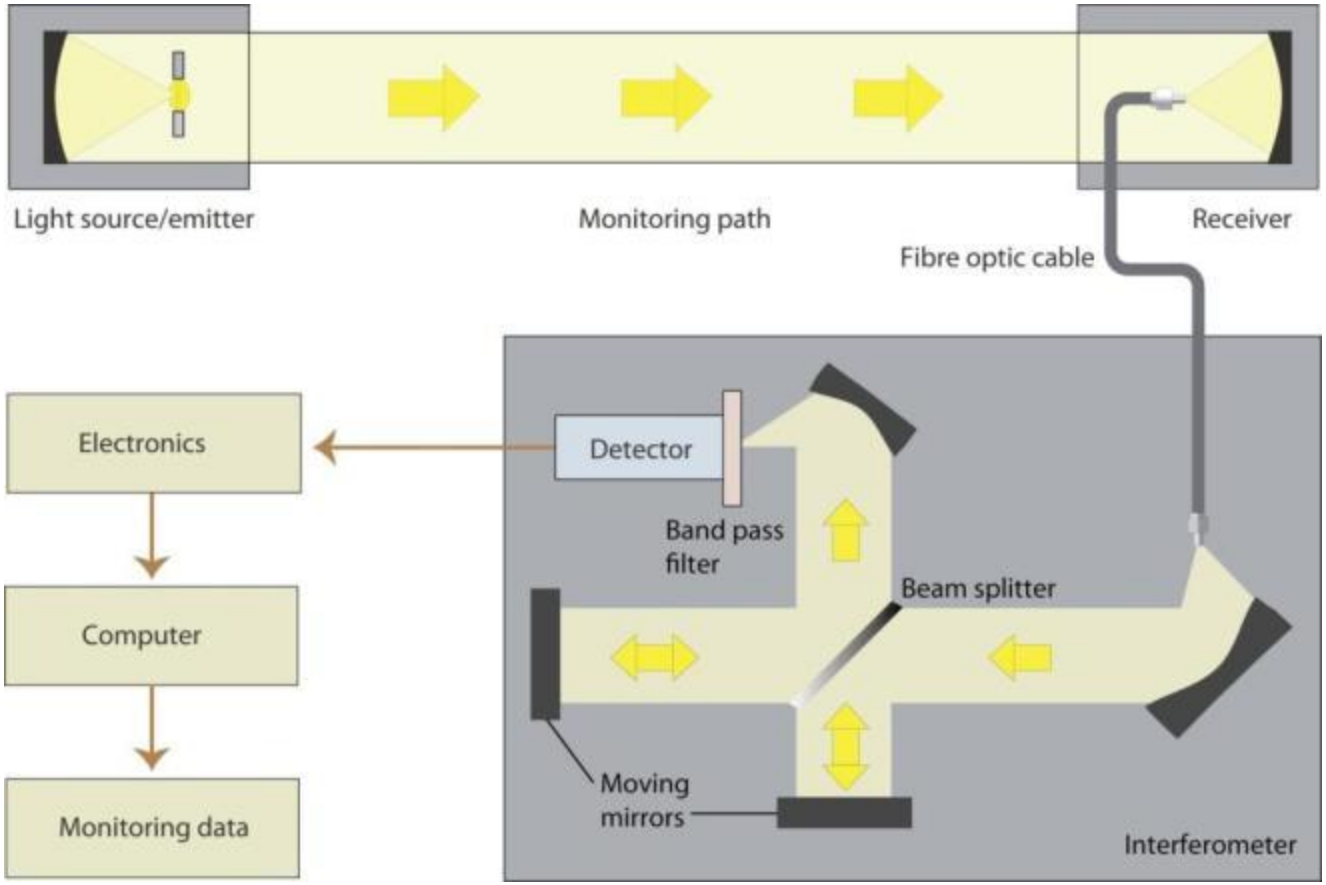
For gas compounds such as :

- Nitrogen Oxides (NO, NO_2)
- Ammonia
- Sulfur Dioxide
- Naphtalene
- Benzene
- Toluene
- Xylenes
- Mercury
- Chlorine

and more…

IR DOAS

DOAS= Differential Optical Absorption Spectroscopy)



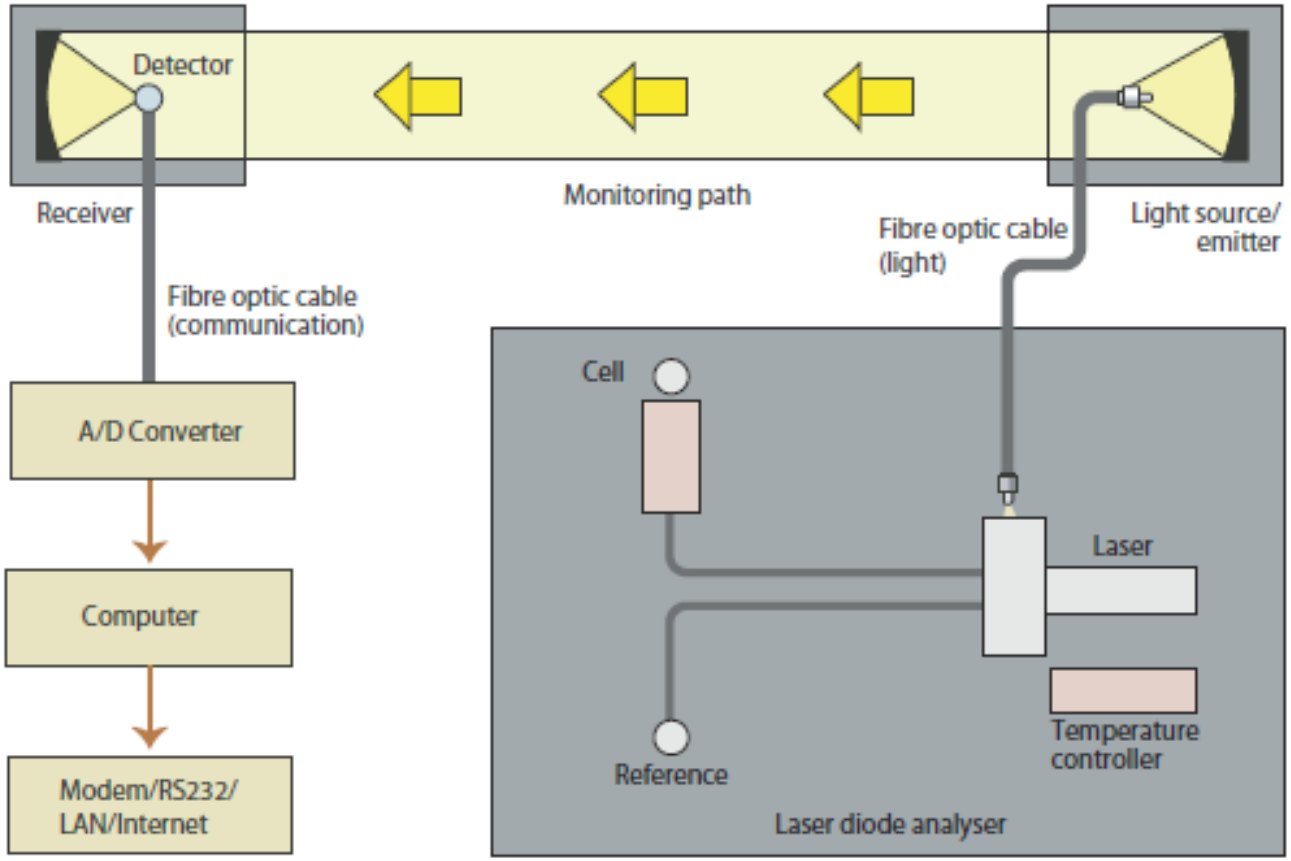
For gas compounds such as :

- Hydrogen Chloride
- Carbon Monoxide
- Carbon Dioxide
- Hydrogen Fluoride
- Moisture
- Bromine
- Iodine
- Methane
- Propane
- Ethane
- Hydrogen Sulfide
- Total Hydrocarbons

and more…

TDL

TDL = Tuneable Diode Laser)

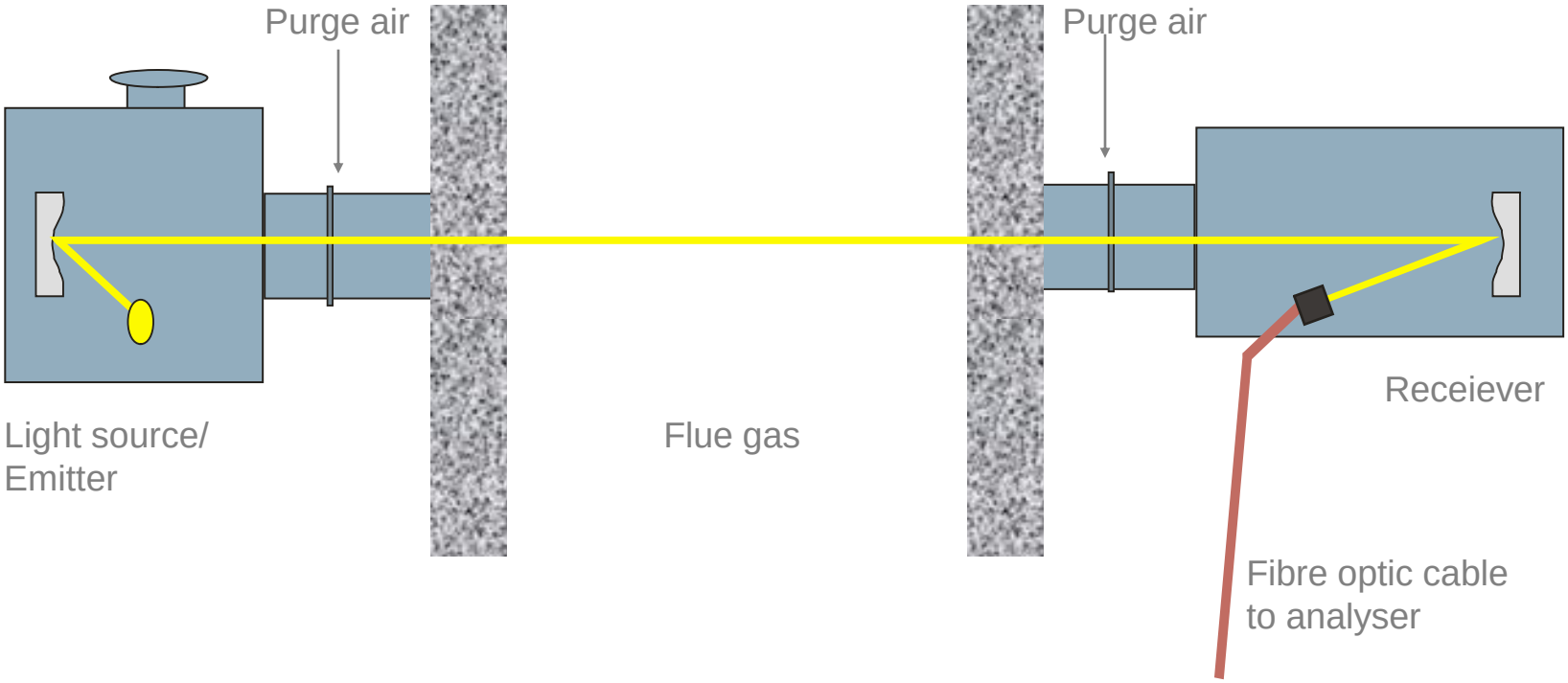


For gas compounds such as :

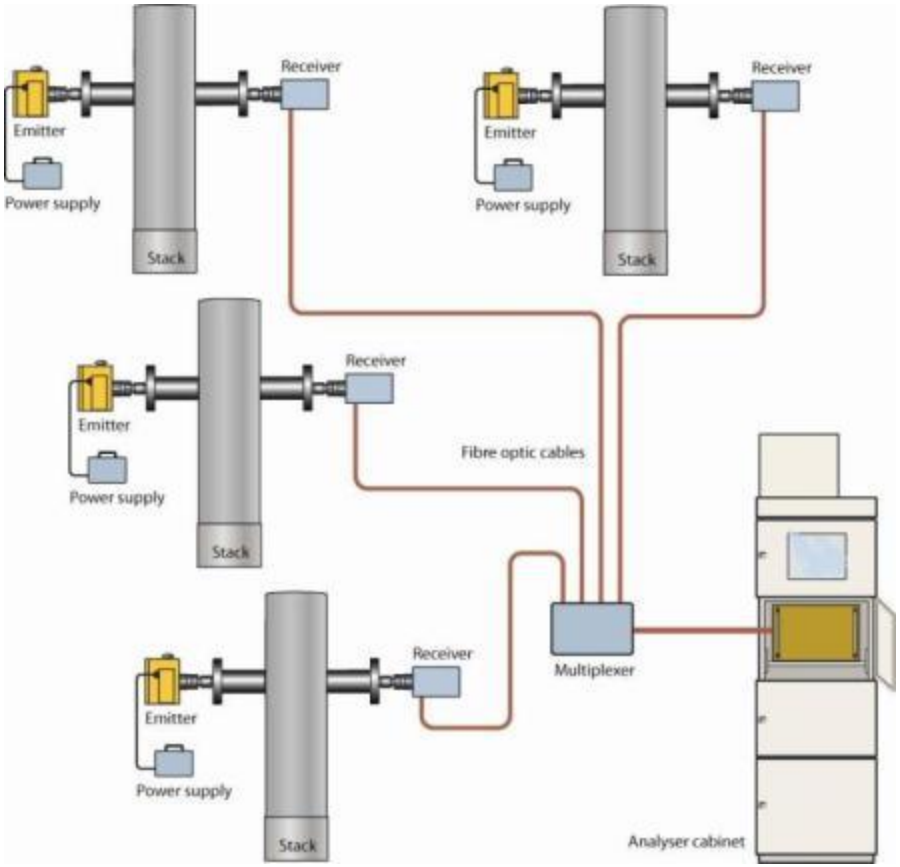
- Hydrogen Chloride
- Carbon Monoxide
- Carbon Dioxide
- Hydrogen Fluoride
- Moisture
- Ammonia
- Oxygen
- Methane
- Hydrogen Sulfide

and more…

EMITTER AND RECEIVER



MULTI –PATH APPLICATIONS



- Reduced cost
- Reduced maintenance
- Reduced calibrations
- Suitable for DeSOx,DeNox

INSTALLATION OVERVIEW

DOAS Emitter

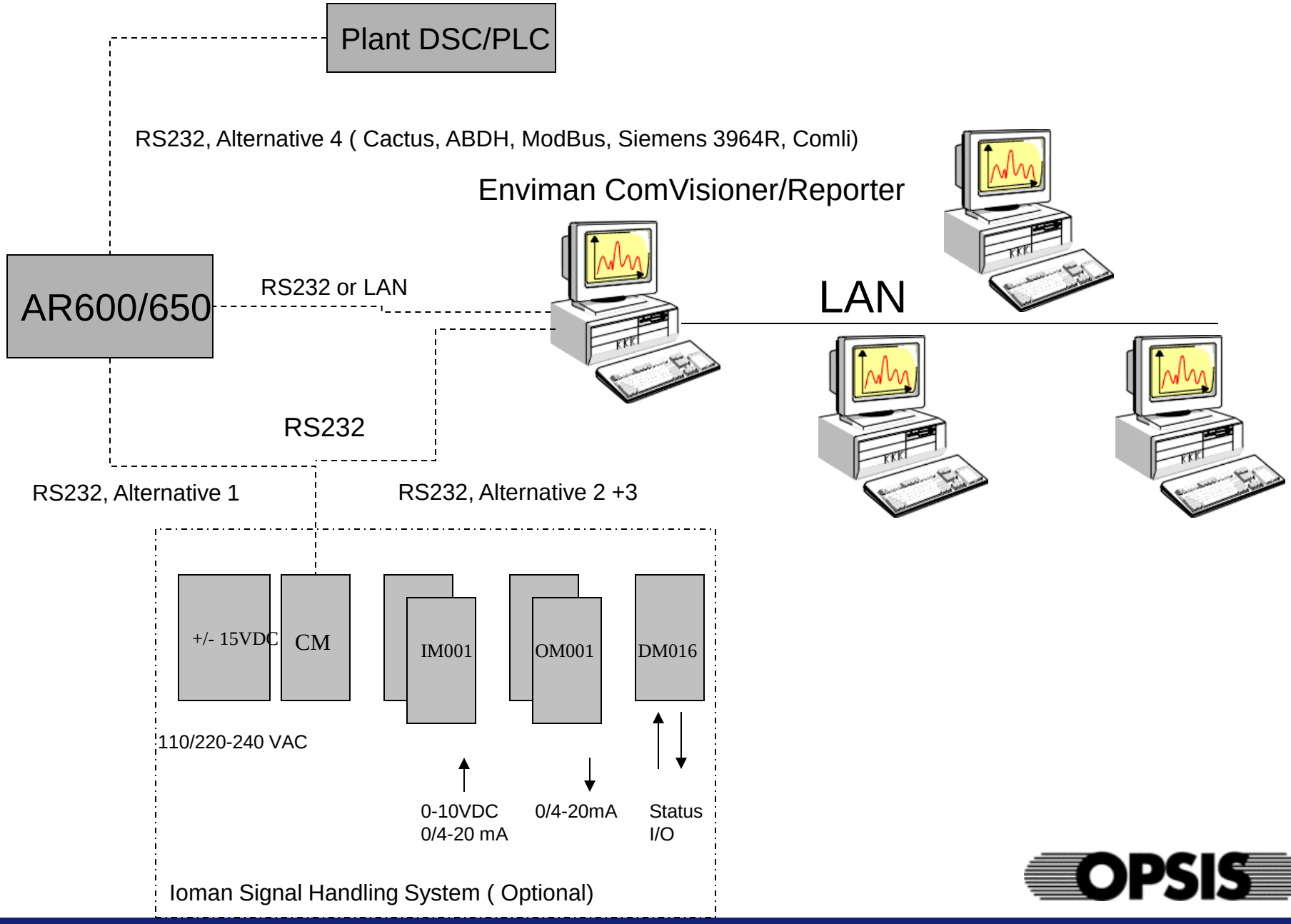
DOAS Receiver

INSTALLATION OVERVIEW

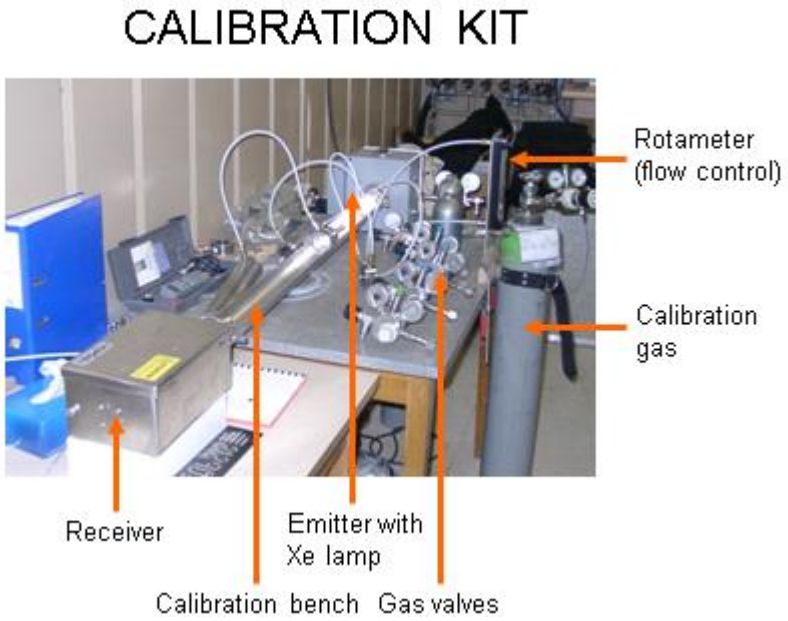
DOAS Analysers

Analyser shelter

SIGNAL/COMMUNICATION



CALIBRATIONS



The DOAS system has very low zero/span drift and is recently approved/certified by German TÜV for a calibration interval of 12 months

DOAS calibration kit does not require gas calibrators or dilutors, instead, calibration cells with various length are used together with standard gas

AUTOMATIC INTERNAL QA/QC

- A number of internal system checks and self calibrations are done automatically, checking wavelength precison, spectral errors , etc, and will provide status /alarms if out of range.

- A number of automatic data validation functions/filters are available in the analyser for light levels , standard deviations and signal/noise ratio

DOAS SYSTEM MAINTENANCE

- Check light levels on daily basis (automatically with status signals/alarms)
- Replace lamp every 6 months
- Calibration yearly (or according to local requirements)
- Replace HeNe laser in IR DOAS every 24-36 months
- Replace sweep wheel bearing in UV-DOAs Every 5 years

HIGHLY QUALIFIED SUPPORT TEAMS

LOCAL SUPPORT IN THAILAND

- Sithiphorn Associates , Thailand, has been Opsis Distributor for more than 25 years !
- Sithiphorn has many experienced engineers that has been trained in Sweden
- Sithiphorn can provide best possible support, maintenance contracts , calibration services etc

ENVIMAN SOFTWARE

Includes about 30 software modules to be used for....

- Data acquisition
- Data presentation and reports
- Emission inventory setup
- Dispersion modelling

ENVIMAN DATA MANAGEMENT SOLUTION

Input from any type of station/sourc

Server for the data processing & distribution

DENR /EMB Users

Output/Reports

CEMS Pollution Data from industries

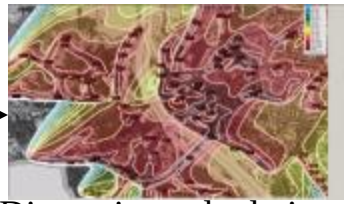
Monitored Air Quality Data

Met. Data

Digital Map Data /(GIS)

Presentation, reports and statistical analysis of monitoring data

Emission simulations

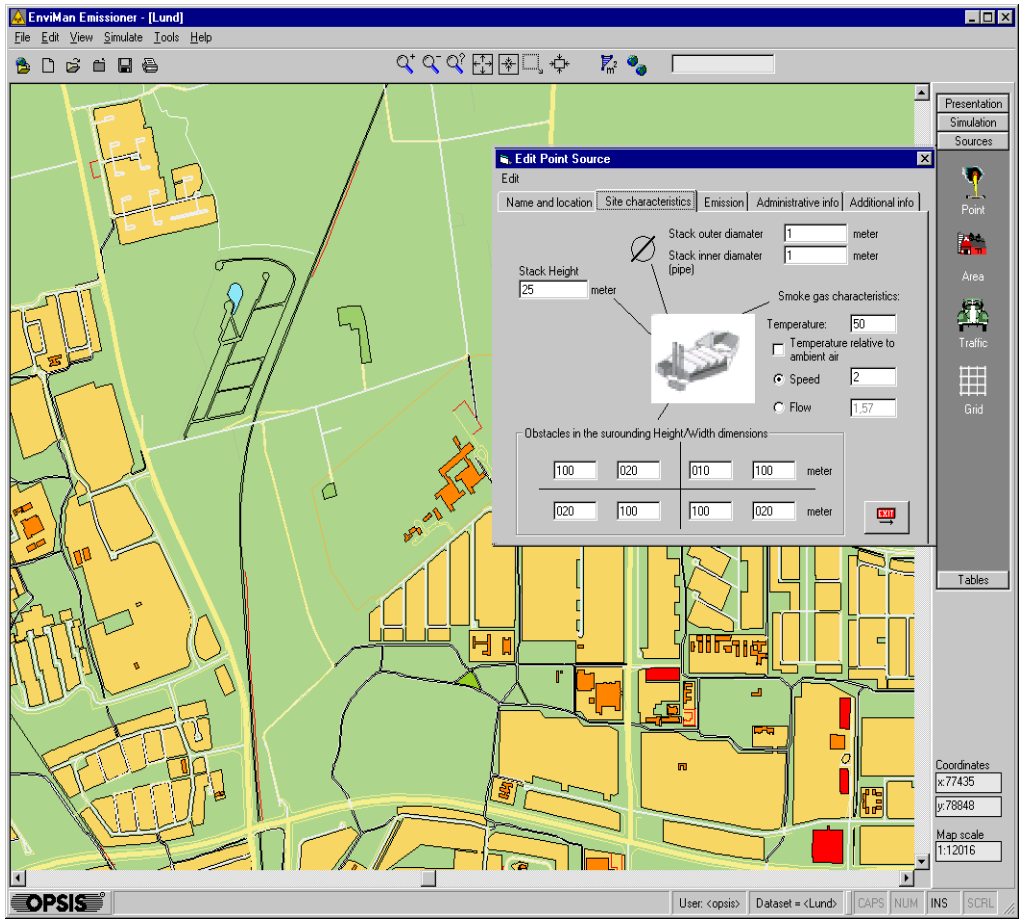


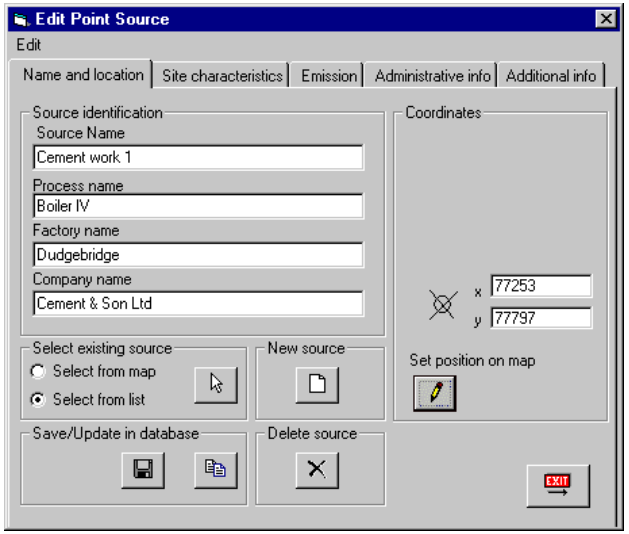
Dispersion calculations

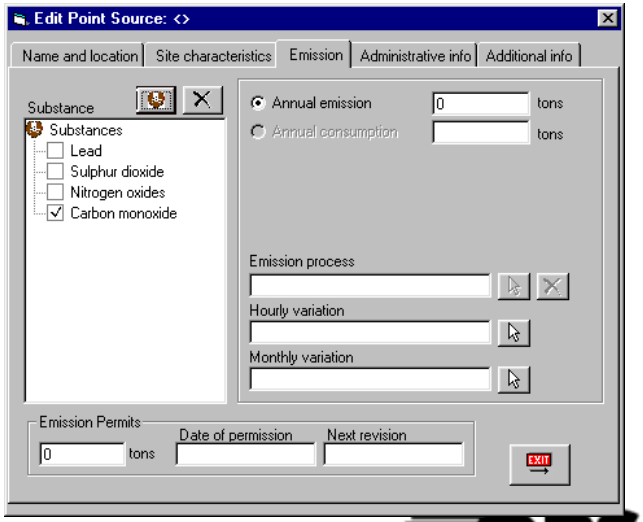
LAN/WAN or Internet

OPSIS

CREATE A DATABASE OF POLLUTION SOURCES







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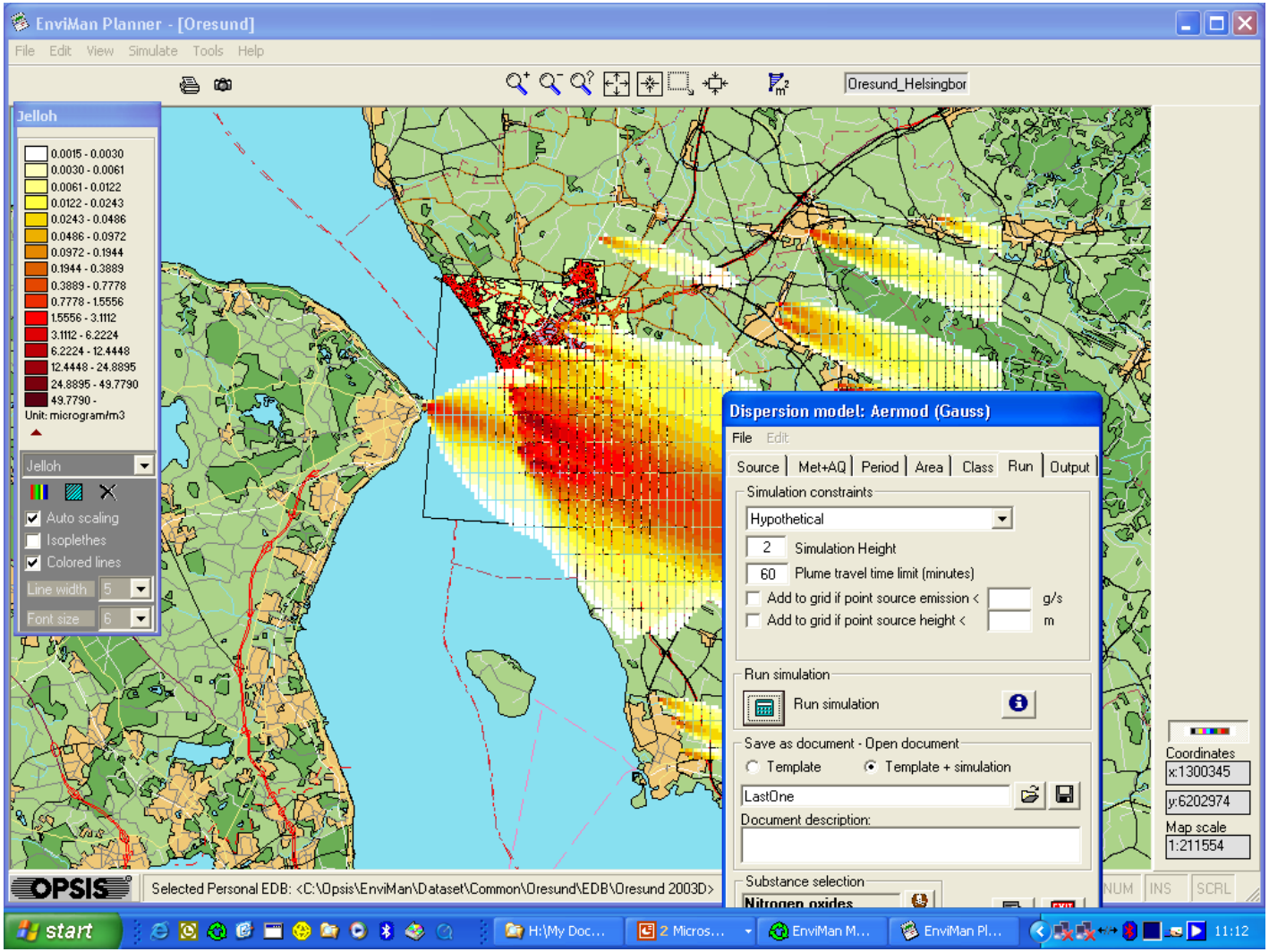
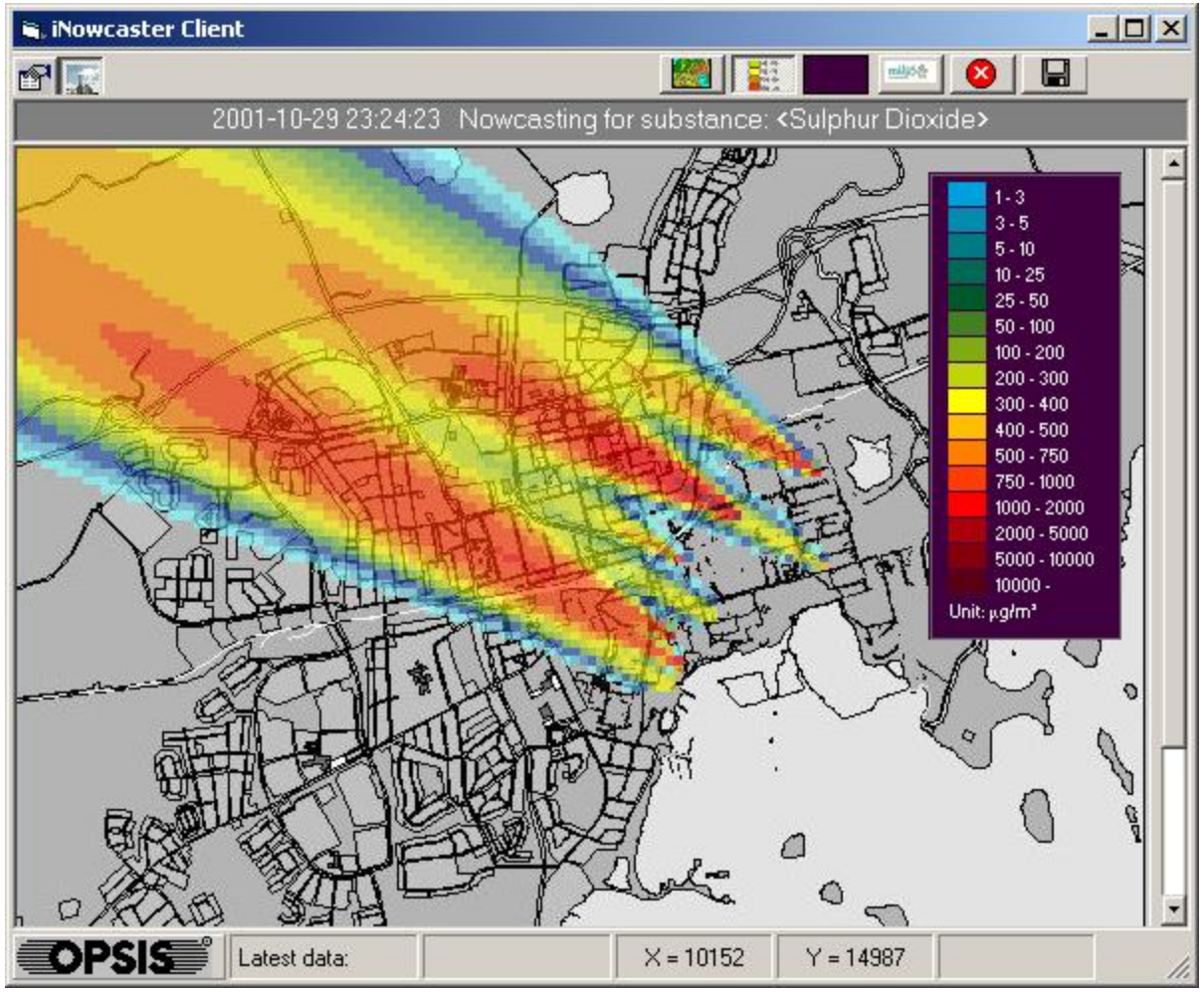
DISPERSION MODELLING



NOWCASTING



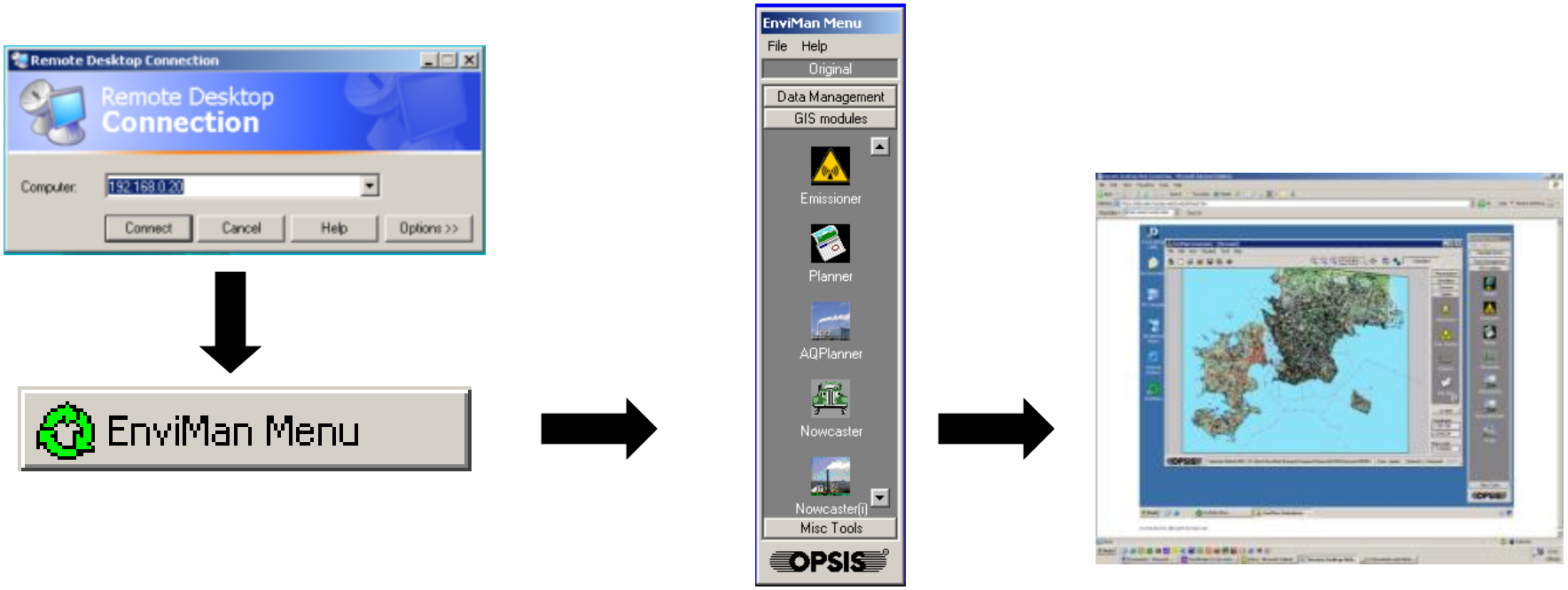
Real time dispersion model

Requires real time CEM data , met data and a dispersion model.

Validation by installed AQM station

WORK FROM ANYWHERE

- Work remotely over internet / LAN using remote desktop connection
- Work on private or global projects
- Using Microsoft Terminal Server solution



www.opsis.se