SIEMENS

Process Analytics

Emission Monitoring

Guidance Book

Brochure

Edition 2018

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Introduction

The need to monitor and report emissions from chemical manufacturers, power generation and waste incineration processes has long been accepted as a legitimate demand placed upon industry to protect our environment. Recent environmental legislations set stricter limits on various atmospheric pollutants from industrial installations.

UNFCCC

The United Nations Framework Convention on Climate Change (UNFCCC) is an international treaty negotiated at the UN conference held in Rio de Janeiro in June 1992. It entered into force in 1994 and, as of March 2014, has 196 parties.

The objective of the treaty is to stabilize greenhouse gas concentration in the atmosphere at a level that would prevent dangerous interferences with the climate system. The treaty is not legally binding but provides a framework for negotiating specific international treaties (called "protocols") that may set binding limits on greenhouse gases.

The parties met annually from 1995 in conferences to assess progress in dealing with climate change. In 1997, the Kyoto Protocol was concluded and established legally binding obligations for developed countries to reduce their greenhouse gas emissions.

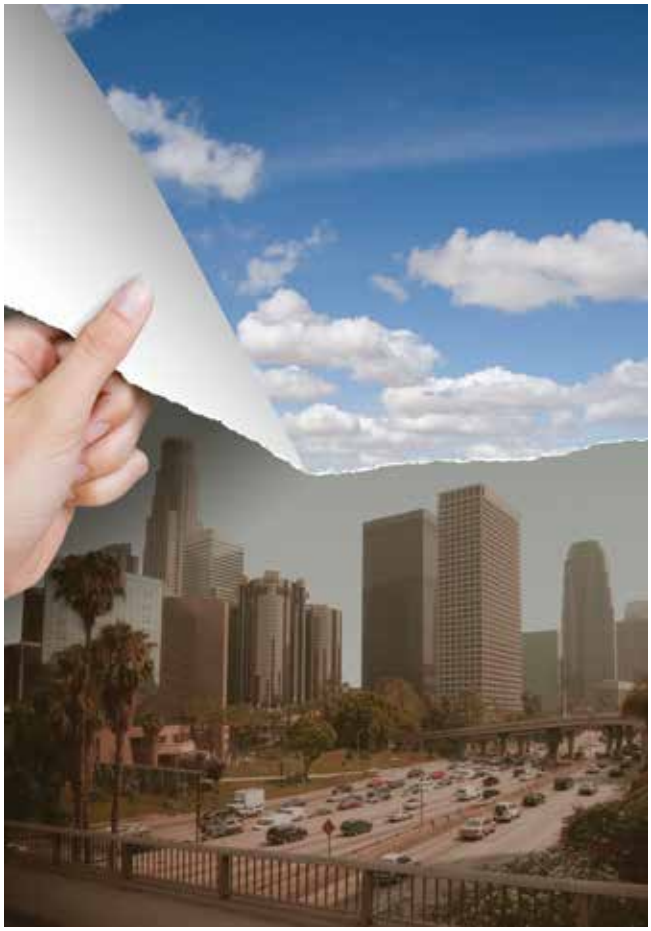
One of the first tasks set by UNFCCC was for signatory nations to establish national inventories of greenhouse gas (GHG: carbon dioxide, methane, nitrous oxide, fluorinated gases) emissions and removals. Inventories must be updated regularly and submitted by the parties.

2 commitment periods have been agreed:
During 1st period (2008-2012) target was to reduce emissions by an average of 5% below 1990 levels. In actual 2nd period (2013-2020) parties who joined this period committed to reduce emissions by at least 18% below 1990 levels.

At the Paris climate conference (COP21) in December 2015, 195 countries adopted the first-ever universal, legally binding global climate deal.

The Paris agreement sets out a global action plan to put the world on track to avoid dangerous climate change by limiting global warming to well below 2°C. It is due to enter into force in 2020.

This document outlines Siemens capability to help the clients meet their obligations under the relevant laws as, e.g. in Europe, the Industrial Emissions Directive 2010/75/EU or the Medium Combustion Plant directive MCPD 2015/2193/EU. Alternatively, if emissions monitoring needs are less demanding and not part of a controlled process, we can still supply suitable solutions.



Content

Siemens Product Portfolio for Continuous Emission Monitoring

Whether you need the individual components for your emissions monitoring project or a fully integrated system, Siemens can deliver the solution.

Siemens diverse and state of the art solutions for continuous emissions monitoring not only help our customers in complying with the regulatory requirements and standards but also in improving the overall operational efficiency of your plant and specific processes while taking an active role in protecting the environment.

A global issue

For decades, governmental and public pressure exists to stop global warming by reducing emissions of gaseous and particle pollutants into the atmosphere. Sources in question are conventional coal fired power plants, heavy industry applications such as cement or aluminum plants, chemical processes, marine engine exhaust gases and many more.

International and national directives have been developed and are continuously tightened to limit and reduce the level of still permitted pollutant concentrations. Continuous monitoring of emitted pollutants is the key precondition to determine the level of emissions from a source and to ensure compliance with existing legal requirements.

Siemens as leading CEMS provider

Continuous emission monitoring systems (CEMS) are the equipment of choice for this challenge. Siemens, as an international leader in providing extractive and in-situ continuous process gas analyzers, process gas chromatographs as well as customized analyzer systems to all kinds of industries, is also your key partner in planning, manufacturing, installing and servicing CEMS worldwide.

With our wide product portfolio and extensive application expertise, we offer standard or customized CEMS solutions to all kind of industries in all parts of the world.

Global support

CEMS are used to ensure and prove full compliance with legal requirements. Thus, reliable operation and trustable results are of utmost importance. The global presence of the Siemens service organization offers optimum support in this aspect through fast response time on-site if required. Furthermore, our service specialists are acquainted with the local and regional requirements, standards and directives and may advise and support our customers in relevant objectives.

Gas analyzers

ULTRAMAT 23

ULTRAMAT 23 is an extremely economical and space saving multi-component gas analyzer also suitable for emission monitoring. It uses NDIR technology for monitoring up to three infrared active components and optionally electrochemical or paramagnetic cell for oxygen measurement.

Highlights and benefits

- Automatic calibration function using ambient air. Check with calibration gases only once a year.
- Menu-guided operation with plain text allows users and service personnel to operate the device immediately
- Logbook information supports preventive maintenance
- Multi-layer detectors ensure high selectivity and reduced water vapor interference
- QAL 1 approval

Technical specifications (selected)

Measurement	Concentration of up to four components simultaneously CO, NO, SO_2, O_2
Measuring principle	Non-dispersive infrared (NDIR) spectroscopy; electrochemical cell; paramagnetic
Typical measuring ranges for CEM	CO: 0 ... 150[1]/250[2] mg/m³
	NO: 0 ... 100[1]/400[2] mg/m³
	SO_2: 0 ... 200 mg/m³
	O_2: 0 ... 5/0 ... 25 Vol%; 0 ... 2/0 ... 100 %
Ambient temperature	5 ... 45 °C
Protection class	IP20
Output	0/2/4 ... 20 mA; 8 x relay; RS 485
	Option: PROFIBUS DP and PA
Conformities	See table (Appendix 1)

[1] One and two IR-components [2] Three IR-components

ULTRAMAT 6

ULTRAMAT 6 determines up to four infrared active gas components in a single unit. Designed for demanding applications, the device meets highest standards with regards to reliability and measuring quality.

Highlights and benefits

- Optical couplers and the optional use of optical filters increases the selectivity and allows correct measurements even in complex gas mixtures and with lower detection limits.
- The analyzer can be used even for measurements in gas mixtures with corrosive components
  - By use of appropriate materials
  - By design: E. g. detector does not come in contact with the sample gas.
- QAL 1 approval

Technical specifications (selected)

Measurement	Concentration of CO, NO, SO_2 and other
Measuring principle	Non-dispersive infrared (NDIR) spectroscopy
Typical measuring ranges for CEM	CO: 0 ... 50 mg/m³
	NO: 0 ... 100 mg/m³
	SO_2: 0 ... 75 mg/m³
Ambient temperature	5 ... 45 °C
Protection class	IP20 (rack unit), IP65 (field unit)
Output	0/2/4 ... 20 mA; 6 x relay; RS 485
	Option: PROFIBUS DP and PA
Conformities	See table (Appendix 1)

Gas analyzers

OXYMAT 6

OXYMAT 6 measures oxygen using the paramagnetic alternating pressure technology. This enables perfect linearity and allows parameterization of minimal measuring ranges.

Highlights and benefits

- The analyzer can be used even for measurements in gas mixtures with corrosive components
  - By use of appropriate materials
  - By design: E. g. detector does not come in contact with the sample gas.
- No moving parts for long lifetime at low maintenance efforts
- Fast response time
- QAL 1 approval

Technical specifications (selected)	
Measurement	Concentration of O_2
Measuring principle	Paramagnetic alternating pressure principle
Typical measuring ranges for CEM	0 ... 5 Vol% and 0 ... 25 Vol%
Ambient temperature	5 ... 45 °C
Protection class	IP20 (rack unit); IP65 (field unit)
Output	0/2/4 ... 20 mA; 6 x relay; RS 485
	Option: PROFIBUS DP and PA
Conformities	See table (Appendix 1)

ULTRAMAT/OXYMAT 6

ULTRAMAT/OXYMAT 6 multi-component gas analyzer combines the analytical benches of both analyzers in one 19" rack providing one oxygen channel and one channel for up to two IR-active components.

SIPROCESS UV600

SIPROCESS UV600 is an extractive UV-based gas analyzer to measure up to three components simultaneously. It is a specialist for extremely selective NO measurement with small measuring ranges and also suited to determined other UV-active gases, e.g. NO_2, SO_2 and H_2S.

Highlights and benefits

- Simultaneous measurement of NO and NO_2 with subsequent compilation
- NO_2 converter not required (lower maintenance effort)
- Measurement not affected by H_2O and CO_2
- Measurement of very low NO concentration (measuring range 0 to 15 mg/m³)
- QAL 1 approval

Technical specifications (selected)	
Measurement	Concentration of up to three components simultaneously: NO, NO_2, SO_2, H_2S
Measuring principle	UV resonance absorption spectrometry
Typical measuring ranges for CEM	NO: 0 ... 15 to 0 ... 1 400 mg/m³
	NO_2: 0 ... 20 to 0 ... 2 000 mg/m³
	SO_2: 0 ... 25 to 0 ... 2 600 mg/m³
	H_2S: 0 ... 40 to 0 ... 1 500 mg/m³
Ambient temperature	5 ... 45 °C
Protection class	IP40
Output	4 x 0/4 ... 24 mA; 8 x relay; RS 485; Ethernet (LAN)
Conformities	See table (Appendix 1)

FIDAMAT 6

FIDAMAT 6 gas analyzer is suitable for the determination of the total hydrocarbon content (THC) in air and in flue gases as well as in solvent recovery processes and cement plants.

Highlights and benefits

- Measuring range down to 0 to 15 mg/m³
- Low fuel consumption
- Auto-start and safety shutdown
- Suitable for measurements in the presence of corrosive gases
- Options for internal sample gas pump
- Non-plugging capillary sample inlet
- QAL1 approval

Technical specifications (selected)	
Measurement	Total hydrocarbon content (C_nH_m)
Measuring principle	Flame ionization
Typical measuring ranges for CEM	0 ... 15 mg/m³
Ambient temperature	5 ... 45 °C
Protection class	IP20
Output	0/2/4 ... 20 mA; 6 x relay; RS 485
	Option: PROFIBUS DP and PA
Conformities	See table (Appendix 1)

LDS 6

LDS 6 diode laser gas analyzer is based on the specific light absorption principle of different gas components which is unaffected by cross-interferences. LDS 6 is suitable for fast in-situ measurements of gas concentrations in process and flue gases.

Highlights and benefits

- In-situ measurement at process conditions
- Highly selective (no cross interferences)
- Insensitive to dust and misalignment
- Real-time measurement
- No sample conditioning required
- Self-calibration by built-in reference cell
- Minimum maintenance requirements
- QAL 1 approvals for HCl, NH_3, and H_2O

Technical specifications (selected)	
Measurement	Concentration of NH_3, NH_3/H_2O, H_2O, HCl, HCl/H_2O, HF, HF/H_2O, CO/CO_2
Measuring principle	Tunable diode laser absorption spectrometry
Typical measuring ranges for CEM	NH_3: 0 ... 15 mg/m³ and 0 ... 20 mg/m³
	HCl: 0 ... 15 mg/m³ and 0 ... 90 mg/m³
	HF: 0 ... 5 mg/m³
	CO/CO_2: 0 ... 5 Vol %/ 0 ... 10 Vol %
Ambient temperature	5 ... 45 °C
Protection class	IP20
Output	4 ... 20 mA; 6 x relay (per channel); Ethernet for Service and Maintenance
Conformities	See table (Appendix 1)

Gas analyzer systems

Set CEM CERT

Set CEM CERT is a standardized and EN 15267 certified continuous emission monitoring system, which is suitable for use in plants which need to comply with European and respective national legislation: MCPD 2015/2193/EU and IED 2010/75/EU; in Germany: 17th BImSchV, 30th BImSchV, 31st BImSchV and TA Luft.

Highlights and benefits

- Complete modular CEMS package including up to 3 gas analyzers, sampling probe, heated sample lines, gas cooler, gas pump, and NOx converter
- Possible gas analyzers: ULTRAMAT 23, ULTRAMAT 6, OXYMAT 6, SIPROCESS UV600, FIDAMAT 6, LDS 6
- Easy to configure and cost efficient in purchase and maintenance
- Sample probe, gas cooler and NO_x converter selectable from leading suppliers
- Versions for indoor or outdoor installation
- Tested and QAL 1 approved measuring ranges to select a variety of ranges for use in different areas of application

Set CEM CERT can be equipped or combined with continuous gas analyzers providing the most common technologies in emission monitoring: NDIR, UV, TDLAS, FID, NDIR, UV, TDLAS, FID. Complete SET CEM CERT based CEM system also may include a NO_x converter, a sampling probe, a heated sample gas line, a two stage sample gas cooler and a gas pump.

The innovative CEMS meets the quality standards EN 14956, EN 15267 and EN 14181 (QAL 1/2/3, AST) which are stipulated by the actual EU directives to be applied for testing the suitability of a device or system.

Application

Emission monitoring of

- Power plants
- Cement plants
- Steel and aluminum plants
- Waste incineration plants
- Glass melting furnaces
- Monitoring of greenhouse gas emissions as part of the EU Emission Trading Scheme (ETS)

Technical specifications (selected)	
Measurement	CO, CO_2, NO, NO_2, SO_2, O_2, HCl, NH_3, H_2O and TOC
Analyzer	Complete Siemens CGA portfolio
Measuring principle	NDIR, NDUV, TDLAS, FID, paramagnetic, electrochemical cell
Typical measuring ranges for CEM	See ranges for incorporated analyzers
Ambient temperature	5 ... 40 °C
Protection class	IP54
Output	0/2/4 ... 20 mA; 8 x relay; RS 485
	Option: PROFIBUS DP and PA
Conformities	See table (Appendix 1)

[1] Depending on configuration

Set CEM 1

Set CEM 1 is a standardized high performance automatic measuring system for monitoring the emission components in flue gases of preferably large combustion plants. It reliably covers all requirements associated with sampling, sample preparation, and gas analysis.

Main system components

- Sampling probe and sample gas line
- Gas analyzers
- Air conditioning unit
- NO_2/NO converter
- Single or double signal processing
- Power supply modules
- Condensate collecting vessel
- Coalescence filter (option)

Sampling probe

The heated sampling probe (DIN flange DN 65, PN 6, power consumption 400 VA) is supplied with a weather protection hood and a 2 µm filter. The maximum dust concentration at the sampling point is 2 g/m³ and the maximum sample gas temperature is 600 °C.

Heated sampling line

The sampling line is heated and regulated at 200 °C, energy consumption is 100 VA/m. The inner wall is PTFE 4/6 coated, maximum length is 35 m, optional more.

Highlights and benefits

- Complete modular package including sampling probe, heated sample lines, gas cooler, gas pump, NO_x converter and ULTRAMAT 23 (NDIR), LDS 6 (in-situ diode laser) and OXYMAT 6 gas analyzers
- Expandable (option) to integrate a second ULTRAMAT 23 analyzer
- Easy to configure and cost efficient in purchase and maintenance
- Available with or without sampling probe
- Simultaneous determination of up to eight components possible, including HCl, HF and NH_3
- Configuration possible for in-situ measurements without sampling and sample preparation
- Simple operation: Large display, several languages, intuitive operation
- Very easy to maintain: Maintenance-friendly cabinet design with hinged frame; digital display of maintenance requests

Technical specifications (selected)

Integrated analyzers	ULTRAMAT 23, LDS 6, OXYMAT 6
Measuring principle	NDIR; laser spectroscopy; paramagnetic alternating pressure; electrochemical cell
Typical measuring ranges for CEM	CO: 0 ... 150 mg/m³ [1]
	NO: 0 ... 100 mg/m³ [1]
	SO_2: 0 ... 400 mg/m³ [1]
	CO_2: 0 ... 5 %
	HCl: 0 ... 15 mg/m³
	HF: 0 ... 5 mg/m³
	NH_3: 0 ... 20 mg/m³
	H_2O: 0 ... 15 (30) Vol%
	O_2: 0 ... 5/0 ... 25 Vol%
Ambient temperature	0 ... 35 °C
Sample gas temperature	Max. 600 °C
Protection class	IP54
Output	0/2/4 ... 20 mA; relay; RS 485
	LDS 6: Ethernet (RJ 45)
	Option: PROFIBUS DP and PA
Power supply	115 V/230 V/400 V modules
Conformities	See table (Appendix 1)

[1] Depending on number of components (ULTRAMAT 23)

Total mercury analyzer system HM-1400 TRX 2

Measuring system for continuous mercury analysis in flue gas stacks gas by measuring mercury vapor. The system uses the extractive measuring principle and includes sampling probe and sampling line.

Application

- Waste incineration plants (municipal, industrial, clinical waste)
- Sewage sludge incineration
- Steelworks with scrap metal reconditioning
- Contaminated soil burning plants
- Crematoriums
- Mercury mines and refineries
- Fluorescent light bulb recycling plants

Highlights and benefits

- Continuous mercury measurement
- Measuring principle allows specification of elemental and oxidized mercury
- Automatic reference point check with internal $HgCl_2$ calibration gas generator
- No extremely heated components, easy to maintain
- Measurement in raw gases with dilution option

Technical specifications (selected)	
Measurement	Concentration of total Hg in sample gas in µg/Nm³
Sample gas	Ambient air, stack gas, process gas
Sample gas flow rate	Min. 70 l/h
	Normal 100 l/h
	Max. 130 l/h
Sample gas pressure (rel.)	-50 ... +20 hPa
Sample gas temperature	0 ... 300 °C
Measuring principle	Determination of the Hg° concentration of the extracted and conditioned sample gas by help of a dual beam UV CVAAS photometer. Oxidized Hg-compounds are converted to Hg° inside a thermal converter.
Typical measuring ranges for CEM	0 ... 45/0 ... 75 to 0 ... 400 µg/Nm³
Duct diameter	> 0.5 m
Protection class	IP54
Outputs	2 x 0/4 ... 20 mA; 9 x relay
Sample probe	Sample probe with inside heated filter element and inlet for heated test gas, Pt100 temperature sensor, controlled by HM-1400 TRX 2, 230 V L, N, PE, 50/60 Hz, 650 VA
Sample line	Temperature controlled 200 °C heated sample line, IP5; Power supply 230 V L,N,PE, 50 ... 60 Hz, 100 VA/m
Conformities	See table (Appendix 1)

Dust, opacity and volume flow measurements devices

D-R 220 Dust and opacity monitor

System for monitoring of dust emissions on smaller plants and in process applications. The system uses the double pass light attenuation principle.

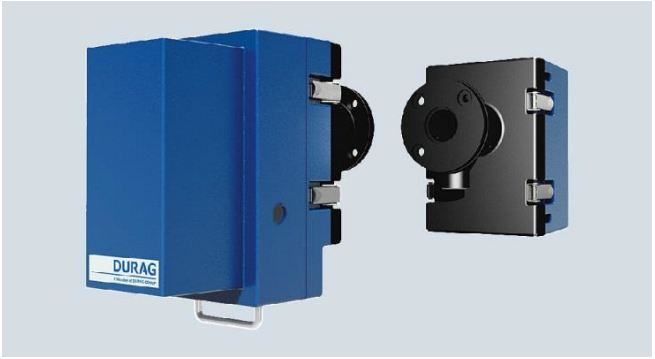
System components
Measuring head, reflector, terminal box with integrated purge air supply and zero point reflector.

Highlights and benefits

- Continuous and contactless measurement
- Automatic internal self-test, zero point and reference point check
- Cost-effective, small measuring system

Technical specifications (selected)	
Measurement	Opacity, extinction
Measuring principle	Transmission
Typical measuring ranges for CEM	0 ... 20 to 0 ... 100 % OP
	0 ... 0.2/0.4 ... 1.6 Ext
	0 ... 160 to 0 ... 4 000 mg/m³ dust
Flue gas temperature	Above dew point to 200 °C, opt. to 500 °C
Flue gas pressure	-50 ... +5 hPa, opt. higher
Ambient temperature	-20 ... +50 °C
Duct diameter	0.4 ... 10 m
Protection class	IP65
Output	0/4 ... 20 mA; 2 x relay
Purge air supply	Integrated into terminal box
Conformities	See table (Appendix 1)

D-R 290 Dust concentration monitor



System for monitoring small to medium dust concentrations, e.g. 20 mg/m³ @ 5 m measuring path length. The device uses the double-pass light attenuation principle.

System components
Measuring unit, reflector, purge air supply unit, terminal box with power supply.

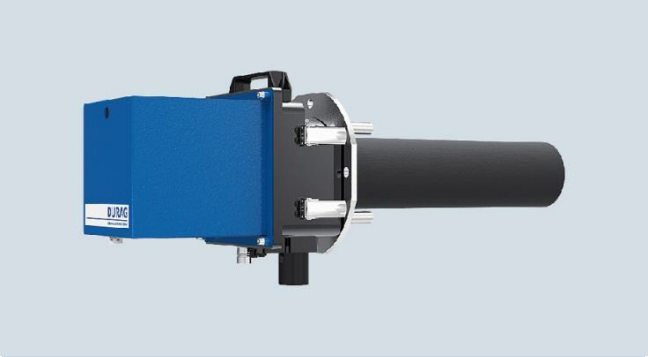
Highlights and benefits

- Continuous and contactless measurement
- Automatic zero and reference point check
- Automatic contamination check and correction

Technical specifications (selected)	
Measurement	Opacity, extinction
Measuring principle	Transmission
Typical measuring ranges for CEM	0 ... 20 to 0 ... 100 % OP
	0 ... 0.1 to 0 ... 2.0 Ext
	0 ... 80 to 0 ... 5 000 mg/m³ dust
Flue gas temperature	Above dew point to 250 °C, opt. to 1 000 °C
Flue gas pressure	-50 ... +20 hPa, opt. higher
Ambient temperature	-40 ... +60 °C
Duct diameter	1 ... 18 m
Protection class/Ex	IP65/opt. Ex
Output	0/4 ... 20 mA; 2 x relay
	Modbus RTU
Purge air supply	Appr. 80 m³/h; protection IP55
Conformities	See table (Appendix 1)

Dust, opacity and volume flow measurements devices

D-R 320 Dust monitor



Dust monitor ideally suited for monitoring smallest to medium dust concentrations The device uses the backscattering principle.

System components
Measuring head, terminal box with integrated purge air supply, universal control unit optional

Highlights and benefits

- Continuous and contactless measurement
- One-sided installation without optical alignment
- Easy installation on standard flanges
- Automatic zero and reference point check
- Automatic contamination check and correction

Technical specifications (selected)	
Measurement	Dust concentration
Measuring principle	Back scattering
Typical measuring ranges for CEM	0 ... 5 mg/m³ to 0 ... 200 mg/m³
Flue gas temperature	Above dew point to 600 °C
Flue gas pressure	-50 ... +50 hPa
Ambient temperature	-40 ... +60 °C
Protection class	IP65
Output	0/4 ... 20 mA; 2 x relay; Modbus RTU
Purge air supply	Integrated into terminal box
Conformities	See table (Appendix 1)

D-R 800 Measuring device for dust concentration

Dust monitor ideally suited for monitoring small to medium dust concentrations. The device uses the forward scattering principle.

System components
Measuring device, terminal box with integrated purge air supply, universal control unit optional.

Highlights and benefits

- Continuous measurement
- One-sided installation without optical alignment
- Automatic zero and reference point check
- Automatic contamination check and correction

Technical specifications (selected)	
Measurement	Dust concentration
Measuring principle	Forward scattering
Typical measuring ranges for CEM	0 ... 5 mg/m³ to 0 ... 200 mg/m³
Flue gas temperature	Above dew point up to 220 °C
Flue gas pressure	-50 ... +50 hPa
Ambient temperature	-40 ... +60 °C
Duct diameter	> 0.3
Protection class	IP65
Output	0/4 ... 20 mA, 2 x relay
Purge air supply	Integrated into terminal box
Conformities	See table (Appendix 1)

D-RX 250 Combined probe sensor

Single rod measurement probe for simultaneous measurement of dust concentration (triboelectic), volume flow, temperature and absolute pressure.

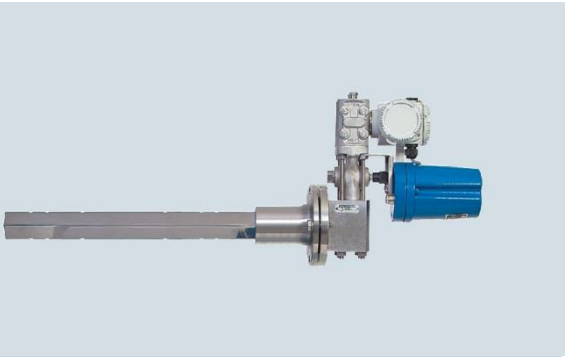
System components
Probe, transmitter, differential pressure transmitter, control and evaluation unit.

Highlights and benefits

- One probe for simultanuous measurement of
  - dust concentration [mg/Nm³]
  - volume flow [Nm³/h]
  - temperature [°C]
  - absolute pressure [hPa]
- Only one probe-/ mounting hole in the exhaust duct
- Compact design
- No moving parts
- Automatic zero and reference point check

Technical specifications (selected)	
Measurement	Dust concentration, volume flow, abs. pressure, temperature
Measuring principle	Triboelectric (dust), differential pressure (volume flow)
Typical measuring ranges for CEM	0 ... 10 to 0 ... 500 mg/Nm³
	0 ... 9 999 999 Nm³/h
	0 ... 200 °C, optional 0 ... 350 °C
	800 ... 1 300 hPa
Flue gas temperature/pressure	Above dew point to 200 °C, opt. 350 °C/-200 ... +200 hPa
Ambient temperature	-20 ... +50 °C
Protection class	IP65
Output	4 x 0/4 ... 20 mA; 7 x relay; Modbus RTU, RS 485
Purge air supply	Back purging 3 bar (optional), purge air supply 2 m³/h
Conformities	See table (Appendix 1)

D-FL 100 Volume flow measuring system



System to measure velocity and volume flow in dry emissions with a probe using the differential pressure principle.

System components
Low probe, differential pressure transducer, absolute pres-sure transducer, temperature transducer, cross-over cock, evaluation unit, universal control unit optional.

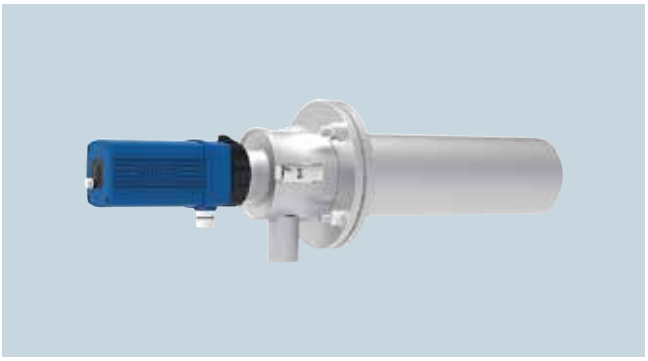
Highlights and benefits

- Continuous measurement
- Versions for use at extreme high temperatures or in corrosive gases available
- Versions with or without counter-support and for point measurement
- Cost effective measurement system
- Representative measurement even at difficult flow conditions

Technical specifications (selected)	
Measurement	Flue gas volume flow, flue gas velocity
Measuring principle	Differential pressure
Typical measuring ranges for CEM	0 ... 3 000 000 m³/h
	3 ... 50 m/s
Flue gas temperature	Above dew point to 450 °C; opt. to 850 °C
Flue gas pressure	-50 ... +50 hPa; opt. higher
Ambient temperature	-20 ... +50 °C
Duct diameter	0.5 ... 8 m
Protection class/Ex	IP 65/opt. Ex
Output	0/4 ... 20 mA; 2 x relay; Modbus RTU, RS 485
Purge air for back purging (if required)	6 ... 8 bar
Conformities	See table (Appendix 1)

Dust, opacity and volume flow measurements devices

D-FL 220 Volume flow measuring system



System for ultrasonic measuring of velocity and volume flow, especially for wet and aggressive smoke emissions.

System components
Two measuring heads, two purge flanges, two mounting flanges, purge air blower, terminal box for power supply.

Highlights and benefits

- Continuous and contactless measurement
- Corrosion resistant ultrasonic transducer
- Ideal for saturated or aggresive flue gases
- Automatic zero and reference point check
- Representative measurement even at difficult flow conditions

Technical specifications (selected)	
Measurement	Gas volume flow, gas velocity, temperature
Measuring principle	Acoustic propagation delay
Typical measuring ranges for CEM	0 ... 5 000 000 m³/h
	0 ... 40 m/s
	0 ... 400 °C
Flue gas temperature	0 ... 300 °C
Flue gas pressure	-50 ... +20 hPa
Ambient temperature	-20 ... +50 °C
	Measuring head: -40 ... +70 °C
Duct diameter	0.5 ... 13 m, temp. dependent
Protection class	IP65
Output	0/4 ... 20 mA; 2 x relay; Modbus RTU
Purge air supply	Appr. 80 m³/h, IP55
Conformities	See table (Appendix 1)

D-ISC 100 Operating and display unit

Universal operating and display unit in stainless steel field housing for the new generation sensors, e.g. D-FL 100, D-FL 220, D-R 220, D-R 290, D-R 320 or D-R 808.

Highlights and benefits

- Quick operation and parameterisation of connected devices
- Connection of several devices to one D-ISC 100
- Combination of two D-ISC 100 per device for local and remote operation
- Modular setup, expandable with expansion modules
- Integrated purge air blower optional

Technical specifications (selected)	
Application	Operating and display unit
Output	0/4 ... 20 mA; 2 x relay
Service interface	USB; Modbus RTU (optional), Modbus TCP (optional)
Ambient temperature	-20 ... +50 °C; opt. -40 ... +60 °C
Housing	Stainless steel
Protection class	IP65
Options	Hardware extension modules: Analog outputs, analog inputs, digital inputs, digital outputs
	Software extension modules: Modbus RTU, Modbus TCP

Components for system integration

Sample probe

A CEM system usually consists of an extractive measuring device and uses a sample probe for extracting samples of flue gas. However, for some measuring components there are also in-situ analysis solutions available. Depending on process conditions, gas matrix (measuring ranges, and interferants, e. g. water, aerosols content) cold- or hot-extractive sampling methods are used.

For hot-extractive sampling a typical stack-gas sample probe is supplied with a one meter stainless steel insertion probe and a heated ceramic filter element with two micron pore size. For optimum performance, the filter is thermostatically regulated to at least 180 °C. Optionally ATEX rated probes, suitable for safe-area operation, are available. The probe and filter are typically mounted on a DN 65/PN 6 flange and all gas-wetted components are manufactured from stainless steel. The whole assembly is designed for operation in harsh and rugged environments and can be supplied with an optional weatherproof cover.

Electrical heating is particularly secure and robust with no external elements or wiring. The complete filter unit is brought up to operating temperature in a controlled fashion to prevent premature burn-out of the heater elements and is automatically controlled. An alarm is available to signify an over/under temperature alarm condition. Ceramic cartridge filters in a wide range of pore sizing are available to suit various applications. The probe assembly is also provided with a test gas port, enabling the whole sample transport system to be challenged for integrity and response time as required.

Heated sample lines

For the sample transport line, typically a trace heated and insulated line, running at 180 °C is included. The sample line is generally 4/6 mm diameter PTFE with stainless steel braiding and is available up to a maximum length of 54 m. Outer sheath is typically of 43 mm diameter, waterproof and flame retardant Polyamide with CFC-free thermo-fleece insulation layer. Temperature control with Pt100 sensor ensures optimum control and stability. Line consumption is approximately 100 - 120 W/m. The sample line should be routed so as to provide a consistent downward slope from the probe to the analyzer shelter avoiding any hollows in which condensed water vapor can collect.

Sample conditioning system

With all analysis applications it is important to present the gas to the analyzers in a clean (free from particulate and moisture) and temperature controlled condition to ensure accurate and trouble free operation. For this reason a fully-configured sample conditioning system is provided along with heated sample probe and transport lines to ensure preservation of sample gas quality.

Analyzer shelters

As part of our system integration services, we can provide a CEM packaged as a basic rack system for mounting in a typical switch or control room. Frequently, such systems need to be mounted closer to the discharge point, in the field or at the base of a stack. Our capability extends to providing "simple" weather-proof GRP enclosure through to customized steel shelters with a full range of ancillary components to ensure ease of operation and technical convenience.

Emission data management systems

For emission data management, Siemens may provide both, dedicated regional as well as international solutions. Please contact your local Siemens Process Analytics sales organization for appropriate solution.

Dedicated regional Siemens solutions

Examples for dedicated Siemens solutions available in some regions are EMIDATE Software, or US Data Acquisition System (DAS) also for CEM applications.

EMIDATE Software (Siemens Austria)
The software solution EMIDATE from Siemens Austria collects, monitors, evaluates and stores all emission related values and plant states. This allows the monitoring of pollutants to permissible limits. The results are graphically visualized and stored.

TÜV-certified
The current version 6.0 was certified by TÜV Austria based on:
- ÖNORM M9412-1:2008 (System 3)
- ÖNORM M9412-2:2008
- ONR 19412-1:2012

Modular system
The system is modular and relies on proven standard components. The data acquisition is done via the industry standard PROFIBUS.

Significant new features of version 6.0
- Expandable multilingualism
- Freely adjustable actual value and compression cycles
- Easy access to stored data (graphs and tables)
- Data of various emission servers can be visualized in one picture
- Acknowledgment for messages including alerting (digital output, PC)

Data Acquisition System (DAS) solutions (Siemens USA)
The DAS solution from Siemens USA is suitable for 40 CFR 60, 63 and 75 and includes: one PC, local rack mount and industrial type EMC station manager software for communications with a Siemens S7 1200 PLC.

DURAG emission data management solutions

Family of modular data acquisition and handling systems (DAHS) for management of environmental and process data according to European & US-EPA regulations:

- D-EMS 2000
  - TÜV certified according to EN 15267
  - MCERTS certified
- D-EMS 2000 CS
  - Price effective compact system for small and middle sized plants
  - TÜV certified according to EN 15267
- D-DAS 2010
  - Cost effective system
  - MCERTS certified
- D-DAS 2000
  - Cost effective system
  - Excellent cost/performance ratio
- UTAS Dr. Lasinger
  - Cost effective system for the Austrian Market
  - ÖNORM M9412-2 certified by TÜV Austria

D-EMS 2000/2020

Data acquisition, evaluation and reporting according to:

- European Industrial Emissions Directive (IED) 2010/75/EU
- US EPA 40 CFR Part 60,63 & 75
- GHG Emission Monitoring (European-, UNFCCC- Guidelines, etc.)
- Country-specific requirements

Management for

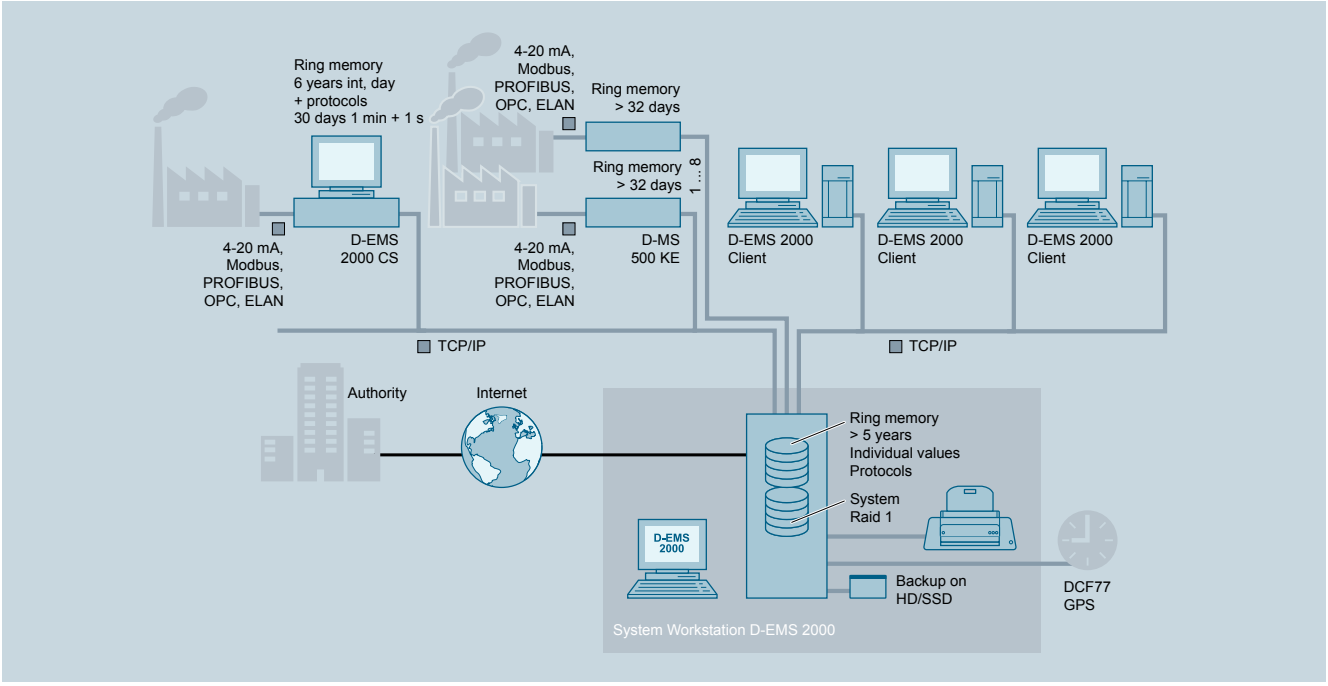
- Emission data
- Water data
- Greenhouse gas (GHG) data
- Ambient air data
- Meteorological data
- Process data etc.

Approvals

- Suitability-tested by TÜV in accordance with German TA Luft, 1st, 2nd, 13th, 17th, 27th, 30th and 31st BImSchV as well as the European Directives 2010/75/EU, 2000/76/EC and 2001/80/EC considering EN 14181
- QAL 1 approved according to EN 15267
- MCERTS certified

Highlights and benefits

- Windows based DAHS with modern designed software running on a standard PC
- User friendly, menu-driven software available in 19 languages
- Data communication unit with internal data storage system for up to 96 days for high data availability
- Handling of up to 320 analog/640 binary in- and outputs, resolution one second
- Interfaces for hardwired 0(4) to 20 mA and/or bus communications TCP/IP, OPC UA, Modbus RTU/TCP, PROFIBUS, Elan etc.
- Encrypted database on two Hard Disk Drive/Solid State Drive as Raid-1-Array
- Menu leaded screens for representation of current, prognostic and historic measured data in bar graph/chart form
- Free configurable screen masks, time diagrams and reports on customer request
- Automatic alarm and information system with comment functionality
- Communication with customer data network incl. interface to MS-Excel
- Automatic data transfer to authority via standard remote communication if required
- Providing of relevant data in the internet/intranet for person in charge, authority or public
- Remote Service Interface for cost effective service and support



Emission data management systems

D-EMS 2000/2020 CS

Price effective compact system for data acquisition and handling for small and middle sized plants

Options
Three device types are available:
- 19" 3HU rack with monitor/keyboard/mouse
- 19" 1HU unit with slide-in keyboard and retractable monitor
- Desktop version with monitor/keyboard/mouse

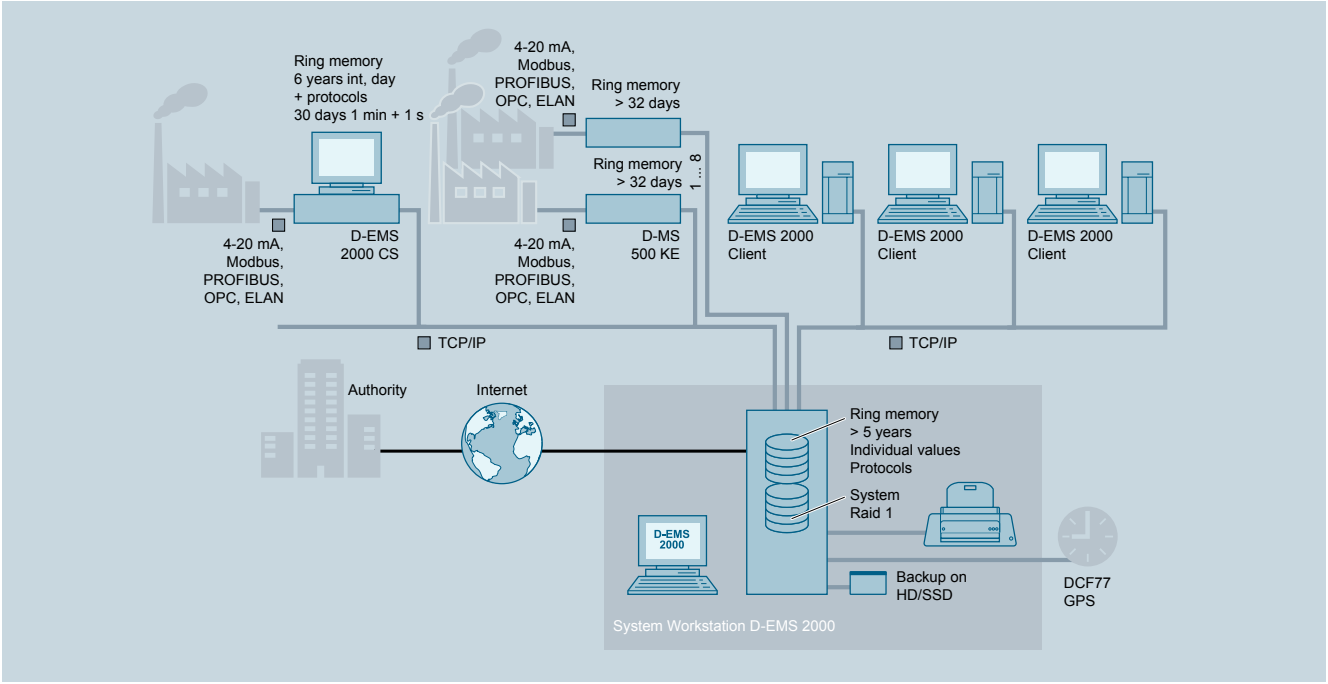
Applications
Emissions evaluation computer for small to medium-sized installations in all types of plants and industries

Highlights and benefits

- Compact system, no additional evaluation PC required
- Modern flash memory technology instead of hard disks
- Independently operating module for acquisition, long-term storage, calculation and visualization of environmental and process data
- Instrument for monitoring officially prescribed limit values with automatic logging
- Continuous monitoring of one to twelve components connected via bus communication or hard wired
- Windows based and certified D-EMS 2000 software
- All modules from the D-EMS 2000 system are usable
- Excellent cost/performance ratio

Technical specifications (selected)

Computer	Intel based Dual core PC with windows 7 & 8, 2 GB RAM and 120 GB SDD
Input/output	Up to three cards
	Combined card: 4 AI/8 DI/2 AO/4 DO
	Input card: 8 AI/15 DI
	Output card(s): 8 AO and 16 DO
Bus system connection	Modbus RTU, PROFIBUS, Elan OPC UA
	Analog-/digital input: 12/24
	Analog-/digital output: 12/24
Interfaces	1 x VGA, 2 x USB, 1 x RJ 45
	3 x serial (RS 232 or RS 485)
	BNC for DCF77-radio clock
Ambient temperature	5 ... 40 °C
Protection class	IP20
Operating voltage	115/230 V AC/50/60 Hz/100 VA



Extended scope of supply

Documentation

The system will be supplied with individual component operating and maintenance manuals along with project specific documentation comprising:

- System schematic
- System piping diagrams
- System operating & maintenance manual
- Individual analyzer manuals
- Maintenance schedule
- Factory test & calibration certificates

Commissioning and start-up

Should your project be a new-build or upgrade, we can provide installation services as part of our project managed delivery. A typical scope would include site survey, preparation of installation drawings, materials supply and management services. Alternatively, our assigned project team can coordinate with your nominated contractor to ensure a seamless process. Installation services will be subject to a separate offer.

Not included, but available at our standard service rates, we offer the services of project trained commissioning engineer to assist with start-up and first-level operator training.

After sales support

We realize that the purpose of an emissions monitoring system is to enable our customers to comply with the law. Therefore the focus of our after-sales offer is on risk mitigation. Every aspect of our support and training portfolio is intended to minimize the risk of downtime and to ensure that any problem is rectified as quickly as possible. Given the stringent limits (and penalties for non-compliance) applied by the environment agencies to permissible downtime of a CEMS, we think it is critical that the supplier of the CEMS should play their part in making sure that these limits are not reached.

Examples for risk mitigations are:

Helpdesk (technical and telephone support)
Rapid access to trained staff in the event of a problem

Field service
Response to site in the event that a site visit is needed to solve the problem

Spares and repairs
We compile our spares lists to include items that genuinely reduce the risk of downtime, because they can be changed on site and avoid the need for sending equipment off site for repair

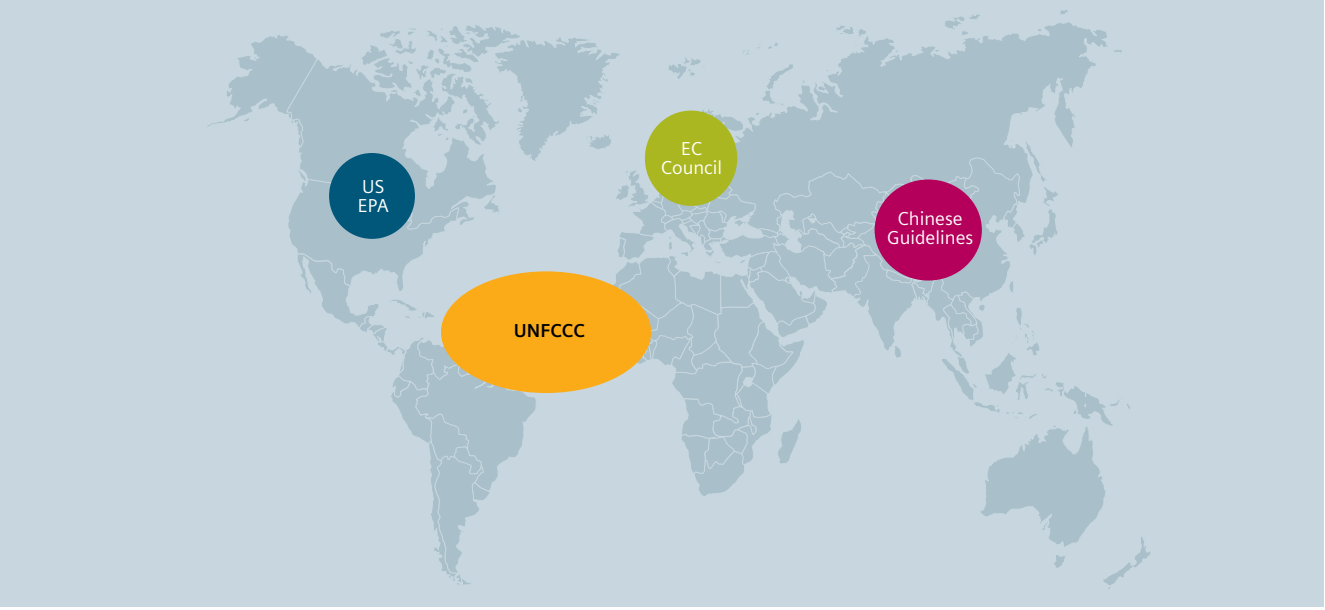
Planned maintenance
Reducing the risk of unscheduled downtime

Service level agreements
Bringing the above elements together into a contract that defines the expectations of both parties

Training
Enabling your operational staff to be the first line of diagnosis and repair

Emission Control Guidelines driven by UNFCCC

European "air quality" directives and standards



Effective monitoring, reporting and verification of greenhouse gas (GHG) emissions is critical for tracking progress towards the achievement of emission reduction targets. The ultimate goal of the UN Framework Convention on Climate Change (UNFCCC) is to stabilize atmospheric concentrations of GHGs at a level which prevents dangerous human interference with the climate system.
All parties and member states to the UNFCCC, its Kyoto Protocol and Paris Agreement are required to report annually on their GHG emissions. Therefore emission control guidelines and Quality Assurance (QA) and Quality Control (QC) Systems have been developed and implemented in different parts of the world to ensure these targets.

European "air quality" directives and standards

European policy concerning the protection of the environment has steadily grown in importance. In particular, the Treaty of Amsterdam (1997) has made a high-level of environmental protection including air quality one of the top priorities. The European Community has aimed to develop an overall strategy and adopted new directives which refer to issues of ambient air quality as well as to stationary source emissions or automotive fuel quality and even to pollutant emission from ships.

Directives for stationary source emissions

Industrial Emissions Directive (IED) 2010/75/EU

The IED (Industrial Emissions Directive of November 24, 2010 on the integrated pollution prevention and control) is the integrated approach to avoid or minimize polluting emissions in the atmosphere, water and soil, as well as waste from industrial and agricultural installations, with the aim of achieving a high level of environmental and health protection.

The IED came into force on January 6, 2011 and is now transposed into national law of EU member states.
The long IED recasts seven former, separate existing directives related to industrial emissions as annexes of the IED, see table below.

Previous legislation		Actual recast		Effective
Integrated Pollution Prevention & Control	2008/1/EC	Industrial Emissions Directive (IED)	2010/75/EU	Jan 7, 2014
Large Combustion Plant Directive (LCPD)	2001/80/EC	Industrial Emissions Directive (IED)	... Annex V	Jan 1, 2016
Waste Incineration Directive (WID)	2000/76/EC	Industrial Emissions Directive (IED)	... Annex VI	Jan 7, 2014
Solvents Directive	1999/13/EC	Industrial Emissions Directive (IED)	... Annex VII	Jan 7, 2014
3 Titanium Dioxide Directives	78/176/EEC, 82/883/EEC, 92/112/EEC	Industrial Emissions Directive (IED)	... Annex VIII	Jan 7, 2014

About 52 000 industrial and agricultural plants with a high pollution potential are affected by IED. Main focus is on reduction and monitoring of emissions of SO_2, NO_x and dust by consequent use of best available technique (BAT).

Industrial installations must use BAT to achieve a high general level of protection of the environment as a whole, which are developed on a scale that allows implementation in the relevant industrial sector, under economically and technically viable conditions. The European Commission must adopt BAT conclusions containing the emission levels associated with the BAT. These conclusions shall serve as a reference for the drawing up of permit conditions.

BAT documents are used as basis for the approval procedure. These requirements shall ensure that plant operators apply BAT consistently and thus comparable competition conditions are generated in the industry.

The emission limit values were significantly reduced by IED, in particular for large combustion plants and are structured according to the kind of fuel as follows:

- Combustion plants using solid fuels
- Combustion plants using liquid fuels
- Combustion plants using gaseous fuels
- Gas turbines and gas engines

Medium Combustion Plants Directive (MCPD) 2015/2193/EU

The MCP Directive regulates emissions of sulphur dioxide (SO_2), nitrogen oxides (NO_x) and dust from the combustion of fuels in plants with a rated thermal input equal to or greater than 1 megawatt (MWth) and less than 50 MWth.

Waste Incineration part (Annex VI of IED 2010/75/EU)

The aim of Annex VI of IED is to prevent or limit, as far as practicable, negative effects on the environment of the incineration and co-incineration of waste, in particular pollution by emissions into air, soil, surface and groundwater and the resulting risks to human health. Annex VI of IED covers the incineration of hazardous waste and non-hazardous waste but excludes exemptions for vegetable waste, radioactive wa ste and animal carcasses.

Annex VI of IED applies not only to facilities intended for waste incineration ("dedicated incineration plants") but also to "co-incineration" plants: facilities whose main purpose is to produce energy or material products and which use waste as a regular or additional fuel, this waste being thermally treated for the purpose of disposal. The directive does not cover experimental plants for improving the incineration process and which treat less than 50 t of waste per year.

European "air quality" directives and standards

Waste Incineration Plants

	Emission limit values [mg/Nm³] for waste incineration plants, standardized at 11 % O_2, mineral waste oil at 3 % O_2						
	Specials/ Thermal input	European directive IED 2010/75/EU			German legislation: 17th BImSchV		
		Limit values, daily average	Limit values, ½ h average, (100 %)[1]	Limit values, ½ h average, (97 %)[1]	Limit values, daily average	Limit values, ½ h average, (100 %)[1]	Limit values, annual average
Dust		10	30	10	5	20	
	< 50 MW				10	20	
TOC		10	20	10	10	20	
HCl		10	60	10	10	60	
HF		1	4	2	1	4	
SO_2 incl. SO_3		50	200	50	50	200	
NO_2 incl. NO					150	400	100
	> 6 t/d	200	400	200			
	< 50 MW				200	400	
Hg					0.03[3]	0.05[3]	0.01[3]
CO		50 (97 %)[2]	100[2]	150 (95 % at 10 min)[2]	50	100	
NH_3	If SCR or SNCR is used				10	15	

[1] Either all validated ½ h averages do not exceed the 100 % limit values or 97 % of the validated ½ h averages do not exceed 97 % limit values.

[2] For CO:
a) 97 % of all daily averages do not exceed daily average limit value.
b) Either all validated ½ h averages do not exceed the 100 % limit values or 95 % of the 10-minutes values do not exceed 10-minutes limit value.

[3] Continuous mercury measurement may be set to non-mandatory, if measuring values reliably will be below 20 % of limit values.

Emission limit values according to IED Annex IV for co-incineration

In case of co-incineration of waste of up to 40 % (IED guideline) or 25 % (17th BImSchV, Germany) of heat release the following formula (mixing rule) is to be applied whenever a specific total emission limit value C has not been defined.
If the heat release from the waste incineration is above 40 % (IED 2010/75/EU) or 25 % (17th BImSchV, Germany), co-incineration plant shall be treated as a normal waste incineration. If the heat release from the waste incineration is less than 10 % of the total heat release, it will be set to 10 %.

$$\frac{C_{proc} * V_{proc} + C_{waste} * V_{waste}}{V_{proc} + V_{waste}} = \overline{C}$$

C: Total emission limit value
V_{waste}: Exhaust gas volume resulting from the incineration of waste only
C_{waste}: Emission limit values set for incineration plants
V_{proc}: Exhaust gas volume resulting from the plant process
C_{proc}: Emission limit values as laid down for certain industrial sectors, e. g. large combustion plants

Waste (Co-) Incineration Plants

	Emission limit values $C_{process}$ [mg/Nm³] for combustion plants co-incinerating waste, new plants				
	General fuel type	Thermal input [MW]	Fuel	European Directive IED 2010/75/EU Limit value, daily average	German legislation: 17th BImSchV Limit value, daily average
Dust	Solid fuel with the exception of biomass (O_2 content = 6 %)	< 50		50	10
		50 ... 300		20	
		> 300		10 (peat: 20)	
	Biomass (O_2 content = 6 %)	< 50		50	
		50 ... 300		20	
		> 300		20	
	Liquid fuels (O_2 content = 3 %)	< 50		50	
		50 ... 300		20	
		> 300		10	
SO_2	Solid fuel with the exception of biomass (O_2 content = 6 %)	< 50	Black coal	Not included	1300
			Lignite		1000
			Fluidized bed		350
		50 ... 100	Black coal, lignite	400 (peat: 300)	400
			Fluidized bed		350
		100 ... 300	Peat	300	200
			Fluidized bed	250	
				200	
		> 300	Fluidized bed	200	200
				150	150
	Biomass (O_2 content = 6 %)	< 50	Natural wood	Not included	200
					350
		50 ... 300		200	200
		> 300		150	150
	Liquid fuels (O_2 content = 3 %)	< 50		Not included	850
		50 ... 100		350	350
		100 ... 300		200	200
		> 300		150	150
NO_2	Solid fuel with the exception of biomass (O_2 content = 6 %)	< 10		Not included	500
		10 ... 50			400
			Fluidized bed		300
		50 ... 100		300	300
			Peat	250	
		100 ... 300		200	200
		> 300	Lignite	200	200
				150	150
	Biomass (O_2 content = 6 %)	< 50		Not included	400
			Natural wood		250
		50 ... 100		250	250
		100 ... 300		200	200
		> 300		150	150
	Liquid fuels (O_2 content = 3 %)	< 50		Not included	350
			Light heating oil		250
		50 ... 100		300	300
			Light heating oil		200
		100 ... 300		150	150
		> 300		100	100
CO	Solid fuel with the exception of biomass (O_2 content = 6 %)	< 50			150
		50 ... 100			150
		> 100			200
	Biomass (O_2 content = 6 %)				250
	Liquid fuels (O_2 content = 3 %)				80
TOC					10
HCl					20
			Fluidized bed		100
HF					1
Hg					0.03

European "air quality" directives and standards

Cement Plants

	Emission limit values [mg/Nm³] for cement and lime plants, new plants		
	Specials	European Directive IED 2010/75/EU Daily average	German legislation: 17th BImSchV Daily average
Dust		30	10
TOC		10	10
HCl		10	10
HF		1	1
SO_2		50	50
NO_2	Cement plants	500	200
	Lime plants		350
Hg		0.03	0.03
NH_3	If SCR or SNCR is used		30
CO		To be defined locally	To be defined locally

Crematories

	Emission limit values [mg/Nm³], daily averages, for human crematories		
		European Directive IED 2010/75/EU	German legislation: 27th BImSchV Daily average
Dust		To be defined locally	10
TOC			20
CO			50

Industrial Emissions Directive (IED, Annex V) for large combustion plants (Recast as Annex V of IED 2010/75/EU)

The IED Annex V aims to reduce acidification, ground level ozone and particles throughout Europe by controlling emissions of sulfur dioxide (SO_2), nitrogen oxides (NO_x) and dust (particulate matter PM) from large combustion plants (LCPs) in power stations, petroleum refineries, steelworks and other industrial processes running on solid, liquid or gaseous fuel. The LCPD covers all combustion installations with a rated thermal output exceeding 50 MW irrespective the type of fuel used with the exception of waste.

The directive shall apply only to combustion plants designed for production of energy with the exception of those which make direct use of the products of combustion in manufacturing processes. The directive entered into force on November 27, 2001.

Combustion plants using solid fuels

	Emission limit values [mg/Nm³], daily averages, for combustion plants using solid fuels with the exception of gas turbines and gas engines, standardized at 6 % O_2, new plants			
	Thermal input and fuel		European Directive IED 2010/75/EU, Limit values	German legislation: 13th BImSchV Limit values
SO_2	50 ... 100 MW	In general	400	400
		Fluidized bed		350
		Biomass	200	200
		Peat	300	400
	100 ... 300 MW	In general	200	200
		Biomass	200	200
		Indigenous fuel	200	300
		Peat	300	200
	> 300 MW	In general	150	150
		Fluidized bed	200	200
		Bio fuels		250
		Indigenous fuel	150	400
NO_2	50 ... 100 MW	In general	300	300
		Lignite	400	400
		Biomass, peat	250	250
	100 ... 300 MW	In general	200	200
		Biomass, peat	200	200
	> 300 MW	In general	150	150
		Lignite	200	200
CO	50 ... 100 MW	In general		150
	> 100 MW	In general		200
TOC	> 50 MW	Bio fuels		10
Hg	> 50 MW	In general		0.03
Dust	50 ... 100 MW	In general	20	10
	100 ... 300 MW	In general	20	
	> 300 MW	In general	10	
		Biomass, peat	20	
Dust	50 ... 100 MW	In general	20	10
	100 ... 300 MW	In general	20	
	> 300 MW	In general	10	

European "air quality" directives and standards

Combustion plants using liquid fuels

	Emission limit values [mg/Nm³], daily averages, for combustion plants using liquid fuels with the exception of gas turbines and gas engines, standardized at 3 % O_2, new plants			
	Thermal input and fuel		European Directive IED 2010/75/EU Limit values	German legislation: 13th BImSchV Limit values
SO_2	50 ... 100 MW		350	350
	100 ... 300 MW		200	200
	> 300 MW		150	150
NO_2	50 ... 100 MW	In general	300	300
	50 ... 100 MW	Heating oil, T > 483.15 K or p > 1.8 Mpa		250
	50 ... 100 MW	Heating oil, T = 383.75 ... 483.15 K or p = 0.05 ... 1.8 Mpa		200
	50 ... 100 MW	Heating oil, T < 383.75 K or p < 0.05 Mpa		180
	100 ... 300 MW	In general	150	150
	> 300 MW	In general	100	100
CO	> 50 MW	In general		80
Dust	50 ... 100 MW	In general	20	10
	100 ... 300 MW	In general	20	
	> 300 MW	In general	10	

Combustion Plants using Gaseous Fuels

	Emission limit values [mg/Nm³], daily averages, for combustion plants using gaseous fuels with the exception of gas turbines and gas engines, standardized at 3 % O_2, new plants			
	Thermal input and fuel		European Directive IED 2010/75/EU Limit values	German legislation: 13th BImSchV Limit values
SO_2	> 50 MW	In general	35	35
		Liquefied gas	5	5
		Coke oven gas	400	350
		Blast furnace gas	200	200
NO_2	50 ... 100 MW	In general	100	200
		Natural gas		100
	100 ... 300 MW	In general	100	100
		Natural gas		200
	> 300 MW	In general	100	300
CO	> 50 MW	In general		80
		Coke oven gas, blast furnace gas		100
		Natural gas	100	50
Dust	> 50 MW	In general	5	5
		Blast furnace gas	10	10
		Steel industry gas	30	

Combustion Plants of Gas Turbines and Gas Engines

	Emission limit values [mg/Nm³], daily averages, for combustion plants of gas turbines and gas engines, standardized at 15 % O_2, new plants (In Germany: gas engines standardized at 5 % O_2)			
	Thermal input and fuel		European Directive IED 2010/75/EU Limit values	German legislation: 13th BImSchV Limit values
NO_2	< 50 MW	Single GT		120
	> 50 MW	< 70 % load	50	50
		Single GT, η > 35 %	50	50 ... 75
		Gas engines @ 5 % O_2	75	200
CO	> 50 MW	In general	100	100
		Gas engines @ 5 % O_2	100	250
Dust	> 50 MW	Liquefied gas		5
		Coke oven gas		350
		Blast furnace gas		200
		In general gaseous fuel		35

The Medium Combustion Plant +-Directive (MCPD)

Medium Combustion Plant Directive (MCPD) 2015/2193/ EU on the limitation of emissions of certain pollutants into the air from medium combustion plants regulates pollutant emissions from the combustion of fuels in plants with a rated thermal input equal to or greater than 1 megawatt (MWth) and less than 50 MWth.

Medium combustion plants (MCPs) are used for a wide variety of applications (electricity generation, domestic/ residential heating and cooling, providing heat/steam for industrial processes, etc.) and are an important source of emissions of sulphur dioxide (SO_2), nitrogen oxides (NO_x) and dust. The estimated number of MCPs in the EU is around 143 000.

The MCP Directive entered into force on 18 December 2015 and actually is transposed by Member States.

It regulates emissions of SO_2, NOx and dust into the air with the aim of reducing those emissions and the risks to human health and the environment they may cause. It also lays down rules to monitor emissions of carbon monoxide (CO).

It fills the regulatory gap at EU level between large combustion plants (> 50 MWth), covered under the Industrial Emissions Directive (IED) and smaller appliances (heaters and boilers <1 MWth) covered by the Ecodesign Directive.

The emission limit values set in the MCP Directive will have to be applied from 20 December 2018 for new plants and by 2025 to 2030 for existing plants, depending on their size. The flexibility provisions for district heating plants and biomass firing will ensure that climate and air quality policies are consistent and their synergies are maximised.

Quelle: http://ec.europa.eu/environment/industry/stationary/mcp.htm

Emission limit values for new medium combustion plants

1. Emission limit values (mg/Nm3) for new medium combustion plants other than engines and gas turbines

See: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015L2193&from=EN

Annex II, Part 2, Table 1 (page 16)

2 . Emission limit values (mg/Nm3) for new engines and gas turbines

See: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015L2193&from=EN

Annex II, Part 2, Table 2 (page 17)

EN 14181 Quality Assurance for Automated Measuring Systems (AMS) = Continuous Emission Monitoring Systems (CEMS)

The above stated European directives including the new IED stipulate that sampling and analyzing of pollutants must be carried out in accordance with CEN standards. The relevant standard is EN 14181 which has been compiled by the technical committee CEN/TC 264 (air quality).It is a European standard related to the quality assurance of automated monitoring systems (AMS) = continuous emission monitoring systems (CEMS) used for measuring emissions from sites operating under the IED. It was approved by CEN on November 3, 2003 and officially released in July 2004. A revised version was released in 2015.

EN 14181 defines which characteristics automatic measuring equipment must possess, and how they must be calibrated and maintained. In addition to the calibration function, the measuring uncertainty - which plays a decisive role in the validation of the measured values obtained during continuous monitoring - is also determined from the data of the calibration experiment. In addition, the requirements for the uncertainty of the measured values obtained with the measuring equipment, which are defined in the EU directives relating to fossil power plants, waste incineration plants and waste co-incineration plants, are checked using a method described in the standard.

The validated average value is defined as the value calculated from the standardized and referenced average value by subtracting the standard deviation (standard uncertainty) at the daily limit value of the standardized values determined by calibration in accordance with EN 14181.

EN 14181 is divided into four main sections and defines three Quality Assurance Levels (QAL) and one Annual Surveillance Test (AST):

QAL 1: Requirements for use of automatic measuring equipment that has had its suitability tested according to EN 15267 and EN ISO 14956

QAL 2: Requirements for installation of automatic measuring equipment (AMS/CEMS), calibration of AMS/CEMS using the standard reference measuring method (SRM), determination of measuring uncertainty/variability of AMS/CEMS and check for observance of preset measuring uncertainties

QAL 3: Continuous quality assurance by the operator (drift and precision of the AMS/CEMS, verification on control card)

AST: Annual surveillance test including SRM measurements to check the uncertainty of the AMS values

	Main objective	Responsible
QAL 1	Suitability test of equipment before purchase (certification)	Instrument supplier
QAL 2	Correct installation and calibration of AMS	Instrument end user
QAL 3	Ongoing quality assurance during plant operation	
AST	Anual check of measuring uncertainty (calibration)	

European "air quality" directives and standards

EN 15267
Certification of Automated Measuring Systems (AMS) = Continuous Emission Monitoring Systems (CEMS) or periodic Emission Monitoring (P-AMS)

Since 2008 the EN 15267 is the actual guideline to certify AMS/CEMS in Europe. It is a harmonization and re-working of the former "type testing" procedures in Germany and the UK. CEN developed EN 15267 because there has been a growing need for a unified set of standards for testing and certifying AMS/CEMS to support the requirements of EC directives and the quality assurance standard EN 14181.

The EN 15267 is divided into four parts:

Part 1: General principles
EN 15267-1 describes the principles of the certification procedure and the roles and responsibilities of the involved institutions (manufacturer, testing institute, certification body, competent authority)

Part 2: Manufacturers QM system
EN 15267-2 refers to initial and yearly repeated assessment of the manufacturer's quality system for design and manufacturing. During the annual audits, any changes to the hardware and/or software of the measuring systems are reviewed and confirmed by further research, if necessary. The manufacturer has to record all performed modifications in a technical logbook.

Part 3: Performance criteria and test procedures
EN 15267-3 defines the performance criteria and test procedures for QAL 1 of AMS/CEMS that measure gaseous emissions, dust and flow rates from stationary sources. It consists of two main parts: The first part specifies the performance specifications which complete AMS/CEMS (for extractive CEMS consisting of defined and tested sample probe, sample line, sampling unit, analyzer, etc.) must achieve during the laboratory tests and field tests.

Part 4: Performance criteria and test procedures for
Periodic measurements of emissions (P-AMS). Latest add-on to EN 15267, part 4, released in 2017, defines performance criteria and test procedures for QAL1 of portable automated measuring systems (P-AMS) intended for (discontinuous) periodic measurements of emissions from stationary sources. As a consequence of portable, periodic measurement task of AMS, mainly laboratory and field test procedures described in EN15267-4 differ from EN15267-3.

Within EN 15267-3 as well as within EN15267-4 a second part then specifies the requirements for testing. Any test laboratory wishing to evaluate AMS must become accredited to ISO 17025 and is obliged to apply EN 15267-3 or EN15267-4 as well as reference-method standards during the laboratory and field tests. The field tests themselves must comply with the major requirements of EN 14181.

After successfully carrying out the extensive laboratory and at least three months field tests, the accredited test laboratory has to present the test report for evaluation and technical examination:
a) in Germany: to the LAI committee
b) in UK: to CSA/SIRA
With positive assessment, the certificate is issued by the German or UK Environmental Agencies for a period of five years. It will be published:
a) in Germany: in the German Federal Gazette and then on the website www.qal1.de
b) in UK: on the website of CSA/SIRA/MCERTS

Validity of EN 15267-3 and EN 15267-4 based QAL 1 approvals for manufacturer is in principle 5 years. It can be enhanced after yearly EN 15267-2 assessment. Then, without hardware or software changes certificate can be renewed for another 5 years after yearly EN 15267-2 assessment.

During the annual audits, inevitably necessary changes of the hardware and/or software of the AMS/CEMS compared to the versions tested during QAL 1 procedure are reviewed and confirmed by further research, if necessary. The manufacturer has to record all performed modifications in a technical logbook. The modifications are classified into the following categories:

- Type 0: No measurable influence on the measuring system
- Type 1: No significant influence
- Type 2: Significant influence. A partial or complete review by the test institute and at least a supplement to QAL 1 approval may be necessary

Emission monitoring guidelines in the USA

The Clean Air Act (CAA) and EPA

The Clean Air Act is the comprehensive federal law that regulates air emissions from stationary and mobile sources and authorizes EPA (Environmental Protection Agency) to protect public health and public welfare and to regulate emissions of hazardous air pollutants.

In this context, EPA set National Ambient Air Quality Standards (NAAQS) for six principal pollutants considered harmful to public health and the environment.

These standards are listed in Title 40 CFR Part 50:

Sulfur oxides	§ 50.4/5
PM	§ 50.6/7
Carbon monoxide	§ 50.8
Ozone	§ 50.9/10
Nitrogen oxides	§ 50.11
Lead	§ 50.12

The Clean Air Act also gives EPA the authority to limit emissions of air pollutants coming from sources like chemical plants, utilities, and steel mills. Individual states may have stronger air pollution laws, but they may not have weaker pollution limits than those set by EPA.

Code of Federal Regulations (CFR)

The CFR is the codification of the general and permanent rules published in the Federal Register by the executive departments and agencies of the Federal Government. CFR is divided into 50 titles, which represent areas subject to federal regulation.

Title 40 CFR
Title 40 CFR arranges mainly environmental regulations that were promulgated by the US Environmental Protection Agency (EPA), based on the provisions of United States laws.

Chapter one (related to EPA) of title 40 is divided into several sub-chapters (A-J , N, O, Q, R, U) with each sub-chapter then divided into parts. Sub-chapter C covers "Air Programs" in parts: Parts 75, 63, 60 and 50 (et al.) refer to emission monitoring aspects. Some of them are described in the following.

40 CFR 75
This chapter establishes basic requirements for the monitoring, record-keeping, and reporting of sulfur dioxide (SO_2), nitrogen oxides (NO_x), and carbon dioxide (CO_2) emissions, volumetric flow, and opacity data from affected units.

The regulations include general requirements for the installation, certification, operation, and maintenance of continuous emission or opacity monitoring systems. Specifications for the installation and performance of continuous emission monitoring systems, certification tests and procedures, and quality assurance tests and procedures are included in appendices A and B to this part. Criteria for alternative monitoring systems and provisions to account for missing data from certified continuous emission monitoring systems or approved alternative monitoring systems are also included in the regulation.

40 CFR 60 (NSPS)
This chapter establishes New Source Performance Standards (NSPS). NSPS are federal standards promulgated for major and minor emission sources. NSPS are emission standards that are progressively tightened over time to achieve a steady rate of air quality improvement without unreasonable economic disruption. NSPS imposes uniform requirements on new and modified sources through the nation. These standards are based on the best demonstrated technology (BDT). BDT refers to the best system of continuous emissions reduction that has been demonstrated to work in a given industry.

40 CFR 60 is broken down into sections and subparts covering performance standards for specific industry stationary source requirements for monitoring, reporting, and testing. Over time there have been added several appendices and performance specifications (reference test methods) associated with 40 CFR 60.

Typical industries and the respective subparts for emissions compliance (Standards of Performances) are:

Subpart E	Incinerators
Subpart F	Portland cement plants
Subpart J	Petroleum refineries
Subpart GG	Stationary gas turbines
Subpart AA	Steel plants: Electric arc furnaces
Subpart Aaa	Steel plants; Electric arc furnaces and argon-oxygen decarburization

Emission monitoring guidelines in the USA

40 CFR 63 (NESHAPS)
This chapter establishes National Emission Standards for Hazardous Air Pollutants (NESHAPS). NESHAPS are emissions standards set by the United States EPA for an air pollutant not covered by NAAQS that may cause an increase in fatalities or in serious, irreversible, or incapacitating illness.

NESHAPS are listed in

Subpart LLL	Portland cement
Subpart UUU	Refinery
Subpart EEE	Waste combustors
Subpart DDDDD	Boilers and process heaters

Quality Assurance and Quality Control (QA/QC) performance specifications

Similar to the European QAL 1 are the QA/QC performance specifications in the US, except that most of the methods and technologies are based on laboratory instrumentation and test methods that typically must be adapted to online process gas analyzers. Within each "stationary source (type) performance specification (PS)" is a section that covers the issue of "Emissions Monitoring & Reporting" and is relevant to the entire CEMS (AMS) installation, monitoring, maintenance, and data reporting. This section will reference all related EPA methods and performance specifications.

Examples are:

Oxygen (O_2)	EPA Method 3A, PS 3
Carbon dioxide (CO_2)	EPA Method 3A, PS 3
Sulfur dioxide (SO_2)	EPA Method 6C, PS 2
Oxides of nitrogen (NO_x)	EPA Method 7E, PS 2
Carbon monoxide (CO)	EPA Method 10, PS 4
Total hydrocarbons (THC)	EPA Method 25A, PS 8
HR (Highly Reactive) VOCs	PS 9

Similar to the European QAL 2 and QAL 3 are the following EPA 40CFR60 QA/QC performance specifications:

- 40 CFR 60, Appendix A, Test Method 1 through 29
- 40 CFR 60, Appendix B, Performance Specifications 1 through 9
- 40 CFR 60, Appendix F, CGAs and RATAs (Relative Accuracy Testing Audits) SW-846 Test Methods, 0010 through 0061
- 40 CFR 266, Appendix IX, Cal Error (CE) and Relative Accuracy Test Audits (RATA)

Responsibilities
The owner/operator of the stationary source is responsible for submitting a QA/QC plan that fully complies with the intent of the relevant stationary source performance specification, monitoring & reporting requirements.
The state agency reviews and approves or denies the plan.

The CEMS supplier is responsible to the owner operator for supplying (engineering & integration) a CEMS. The owner/operator is responsible for the certification of the CEMS in order to obtain a permit.

Emission monitoring guidelines in China

Emission Standard of Air Pollutants for Thermal Power Plants (GB 13223-2011)

This standard was adopted by China's Ministry of Environmental Protection (MEP) on July 18, 2011, and has been effective since January 1, 2012. The standard stipulates limitations on concentrations of air pollutants in emissions from thermal power plants, including soot, SO_2, NO_x, mercury and mercury compounds. The standard does not apply to thermal power plants using domestic waste or hazardous waste as fuels.

Compared to the earlier version, which was established in 2003, the standard makes the following major improvements:

- The standards for soot, SO_2, and NO_x have been tightened considerably.

Emission limit values in China, basic regions			
Type of plant and fuel	**Pollutant**	**Conditions**	**Limits [mg/m³]**
Coal fired boilers	Soot	All	30
	SO_2	New boiler	100/200[1]
		Existing boilers	200/400[1]
	NO_2	All	100/200[2]
	Hg/Hg compounds	All	0.03
Oil-fired boilers or gas turbines	Soot	All	30
	SO_2	New boilers and gas turbines	100
		Existing boilers and gas turbines	200
	NO_2	New oil-fired boilers	100
		Existing oil-fired boilers	200
		Gas turbines	120
Gas-fired boilers or gas turbines	Soot	Natural gas boilers and gas turbines	5
		Other gas-fired boilers and gas turbines	10
	SO_2	Natural gas boilers and gas turbines	35
		Other gas-fired boilers and gas turbines	100
	NO_2	Natural gas boilers	100
		Other gas-fired boilers	200
		Natural gas turbine	50
		Other gas-fired gas turbines	120
Coal-fired, oil-fired, gas-fired boilers or gas turbines	Smoke degree	All	1

[1] To be located in Guangxi Zhuang Autonomous Region, Chongqing Municipality, Sichuan Province and Guizhou Province, where the limits will be implemented with coal-fired boilers.

[2] Implementing limits on W-type thermal power generation boilers or furnace chamber flame boilers, circulating fluidized bed (CFB) boilers, and boilers put into operation as of December 31, 2003 or through the construction project's environmental impact report's approval of coal-fired power boilers.

- The standard distinguishes existing and new sources for SO_2 and NO_x emissions; it provides a two-and-a-half year grace period for existing sources.
- Hg emissions will be controlled for the first time, starting January 1, 2015.

New sources

From January 1, 2012, new thermal power boilers and gas turbines must be controlled under the limits of soot, sulfur dioxide, nitrogen oxides emissions and blackness of smoke (see table).

Existing sources

From July 1, 2014, existing thermal power boilers and gas turbines must be controlled under the limits of soot, sulfur dioxide, nitrogen oxides emissions and blackness of smoke (see table).

Mercury and mercury compounds

From January 1, 2015, coal-fired boilers must be controlled under the limits of mercury and mercury compound emissions as shown in the table.

Normal and key regions

Thermal power boilers and gas turbines located in key regions shall implement special air pollutant emission limits set forth in the following table. The geographic scope of key regions, timeline of the special limits are subject to MEP's further regulation.

Emission limit values in China, key regions			
Type of plant and fuel	**Pollutant**	**Conditions**	**Limits [mg/m³]**
Coal fired boilers	Soot	All	20
	SO_2	All	50
	NO_2	All	100
	Hg /Hg compounds	All	0.03
Oil-fired boilers or gas turbines	Soot	All	20
	SO_2	All	50
	NO_2	Oil-fired boilers	100
		Gas turbines	120
Gas-fired boilers or gas turbines	Soot	All	5
	SO_2	All	35
	NO_2	Gas boilers	100
		Gas turbines	50
Coal-fired, oil-fired, gas-fired boilers or gas turbines	Smoke degree	All	1

Test procedures for CEMS in China

Test procedures for CEMS of flue gas emitted from stationary sources have to follow Chinese guidelines HJ/T76-2007: Specifications and test procedures for continuous emission monitoring systems for SO_2, NO_x and particulate material flue gas emitted from stationary sources.

Emission monitoring guidelines in Hong Kong, India and Malaysia

Emission monitoring guidelines in Hong Kong

The emission limits applied for power plants in Hong Kong are stipulated in BPM 7/1(2014) issued by Environmental Protection Department, Air Policy Group.

A license to be granted for each power plant under the Air Pollution Control Ordinance, the Authority, i.e. the Director of Environmental Protection.

The emissions to be controlled are oxygen, carbon monoxide, particulates (opacity), sulfur dioxide, nitrogen oxides, ammonia (for gas-fired gas turbines) and smokes. Different limits are imposed on the types of power plants.

Emission monitoring guidelines in India

To date in India, pollution standards exist for ambient air quality only but do not for stack emissions from e.g. power plants or other industrial plants, except particulate matter. PM standards, however, are higher compared to those implemented in the USA or EU.

In November 2013 the Central Pollution Control Board published a comprehensive document "Specifications and Guidelines for Continuous Emissions Monitoring Systems (CEMS) for PM measurement with special reference to emission trading programs". The purpose of this document is to serve as a technical specification for accurate, reliable measurement of particulate matter using continuous emissions monitoring systems (CEMS) with reference to their use to support an emissions trading scheme.

The intention for the future is, to (a) revise the emission standards for PM, and (b) to introduce emission standards for other pollutants from stationary sources.

Emission monitoring guidelines in Malaysia

The Environmental Quality (Clean Air) Regulations 1978 and subsequent revisions specify activities and pollutants that are to be monitored and their limit values. The activities specified in the regulations and subsequent revisions are (see also table on next page):

- Heat and power generation
- Production and processing of ferrous metals (iron and steel mills)
- Production and processing of non-ferrous metals with a capacity ≥ 0.5 tons per day for lead or cadmium or ≥ 2 tons per day for other metals
- Oil and gas industries: Refineries (all sizes); natural gas processing and storage, storage and handling of petroleum products
- Non-metallic (mineral) industry:
  - Cement production (all sizes)
  - Manufacture of glass including glass fiber with a melting capacity ≥ 1 ton of products per day
  - Manufacture of ceramic products by firing, in particular roofing tiles, bricks, refractory bricks, tiles, stoneware or porcelain with a production capacity ≥ 10 tons of product per day
- Chemical and petrochemical industry (all sizes)
- Waste incinerators (all sizes)
- Palm oil mills (all sizes)

Plant specific Emission Limit Values (ELVs) for new installations, and recommended measurement technologies								
No.	Plant	Application	Measuring Component		Unit	Additional Requirements/ Comments	Typical Technologies	
							Recommended	Optional
1	Aluminum	Raw Material Handling	Dust/Particulate Matter (PM)	150	mg/m³		In-situ PM	
		Calcination	PM	250	mg/m³		In-situ PM	
			CO	1	Vol%		NDIR	FTIR
		Green Anode Shop	PM	150	mg/m³		In-situ PM	DOAS for open-path (fence) monitoring
		Anode Bake Oven	PM and total fluoride (F)	50	mg/m³	And 0.3 Kg/MT of Al	In-situ PM	
		Pot room	PM (as HF)	150	mg/m³	And Total F 0.8-2.8 kg/MT Al (depending on technology)	In-situ PM	
2	Cement Plant (without co-processing), Standalone Clinker Grinding Plant or, Blending Plant	Rotary Kiln – without co-processing	PM	30	mg/m³		In-situ PM	
			Sulphur Dioxide (SO_2)	100	mg/m³	When pyritic sulphur in the limestone is less than 0.25%	FTIR based hot wet technique to measure CO, CO_2, SO_2, NO, NO_2, (HCl)[1], (HF)[1], (NH_3)[1], VOC, H_2O, etc. Paramagnet for O_2 NDIR / NDUV / FTIR for multigas analysis (SO_2, NO_x)	
				700	mg/m³	When pyritic sulphur in the limestone is 0.25 to 0.5%		
				1 000	mg/m³	When pyritic sulphur in the limestone is more than 0.5%		
			Oxides of Nitrogen (NO_x)	600	mg/m³	In general		
				800	mg/m³	For rotary kiln with In Line Calciner (ILC) technology		
				1 000	mg/m³	For rotary kiln using mixed stream of ILC, Separate Line Calciner (SLC) and suspension preheater technology or SLC technology alone or without calciner		
	Cement Plant with co-processing of waste	Rotary Kiln – with co-processing of waste	PM	30	mg/m³			
			Sulphur Dioxide (SO_2)	100	mg/m³	When pyritic sulphur in the limestone is less than 0.25%		
				700	mg/m³	When pyritic sulphur in the limestone is 0.25 to 0.5%		
				1 000	mg/m³	When pyritic sulphur in the limestone is more than 0.5%		
			Oxides of Nitrogen (NO_x)	600	mg/m³	In general		
				800	mg/m³	For rotary kiln with In Line Calciner (ILC) technology		
				1000	mg/m³	For rotary kiln using mixed stream of ILC, Separate Line Calciner (SLC) and suspension preheater technology or SLC technology alone or without calciner		
			HCl	10	mg/m³		FTIR	In-situ TDLAS
			HF	1	mg/m³		FTIR	In-situ TDLAS
			NH_3			When NO_x-SNCR implanted, to be measured on the stack	TDLAS	FTIR
			TOC	10	mg/m³		FID	
			Hg and its compounds	0.05	mg/m³		Hg CEMS	

1) In-situ laser based method may be preferred for lower concentration

Plant specific Emission Limit Values (ELVs) for new installations, and recommended measurement technologies								
No.	Plant	Application	Measuring Component		Unit	Additional Requirements/ Comments	Typical Technologies	
							Recommended	Optional
3	Distillery	Boiler Stack	PM	150	mg/m³		In-situ	Cross-duct tribo-electric
4	Chlor Alkali	(Hyper tower) (HCl Plant)	Cl_2	15	mg/m³		NDUV (hot-wet)	
			HCl	35	mg/m³	Vapor and mists	FTIR, TDLAS (hot-wet)	
5	Fertilizers	Phosphate	PM	150	mg/m³		In-situ	Cross-duct tribo-electric
			Fluoride	25	mg/m³	Total Fluoride	FTIR, TDLAS (hot-wet)	
		Urea	PM	50	mg/m³		In-situ	Cross-duct tribo-electric
6	Integrated Iron and Steel Plants	Coke oven plant New batteries at GF sites Rebuild	PM	50	mg/m³		In-situ or cross-duct PM NDIR / NDUV, FTIR for SO_2, NO_x, CO Extractive due to high dust, coke, tar	
			SO_2	800	mg/m³			
			NO_x	500	mg/m³			
		Sintering Plant	PM	150	mg/m³			
		Blast Furncase	PM	30	mg/m³			
			SO_2	200	mg/m³			
			NO_x	150	mg/m³			
			CO	1	Vol%			
		Steel making shop-basic oxygen furnace	PM	50	mg/m³			
		Rolling mill, Arc furnaces, Induc-tion furnaces	PM	150	mg/m³			
	Sponge Iron Plants	Cupola foundary	PM	150-450	mg/m³	Depending on melting capacity		
			SO_2	300	mg/m³	Corrected at 12% CO_2		
		Calcination	PM	150-500	mg/m³	Depending on capacity		
		Refractory unit	PM	150	mg/m³			
		Rotary kiln	PM	50	mg/m³	Gas based		
				100	mg/m³	Coal based		
7	Oil Refinery	Furnace boiler and captive power plant gas based	PM	5	mg/m³	Preferably optical based sensor	In-situ	Cross-duct
			SO_2	50	mg/m³		NDIR ($CO/SO_2/NO_x$) / NDUV (NO_x, SO_2) Multi gas / UVF – SO_2 / CLD – NO, NO_2 and CO by NDIR	
			NO_x	250	mg/m³			
			CO	100	mg/m³			
			H_2S in fuel gas	150	mg/m³			
		Furnace boiler and captive power plant liquid fuel base	PM	50	mg/m³	Preferably optical based sensor	In-situ	Cross-duct
			SO_2	850	mg/m³		NDIR ($CO/SO_2/NO_x$) / NDUV (NO_x, SO_2) Multi gas / UVF – SO_2/CLD – NO, NO_2 and CO by NDIR	
			NO_x	350	mg/m³			
			CO	150	mg/m³			
			S content in weight %	0.5	%	In weight %		
		Sulphur recovery unit	H_2S	10	mg/m³			
			NO_x	250	mg/m³			
			CO	150	mg/m³			

Plant specific Emission Limit Values (ELVs) for new installations, and recommended measurement technologies								
No.	Plant	Application	Measuring Component		Unit	Additional Requirements/ Comments	Typical Technologies	
							Recommended	Optional
8	Petrochemical	Furnace, Boiler, Heater, Vaporizer Liquid Fuel based	PM	50	mg/m³	Preferably optical based sensor	In-situ	Cross-duct
			SO_2	850	mg/m³		NDIR ($CO/SO_2/NO_x$) / NDUV (NOx, SO2) Multi gas / UVF – SO_2/CLD – NO, NO_2 and CO by NDIR	
			NO_x	350	mg/m³			
			CO	150	mg/m³			
		Furnace, Boiler, Heater, Vaporizer Gas based	PM	5	mg/m³	Preferably dilution extractive analyzers due to safety issues	In-situ	Cross-duct
			SO_2	50	mg/m³		NDIR ($CO/SO_2/NO_x$) / NDUV (NOx, SO2) Multi gas / UVF – SO_2 / CLD – NO, NO_2 and CO by NDIR	
			NO_x	250	mg/m³			
			CO	100	mg/m³			
9	Power Plant	Thermal Power Plant	PM	30-50	mg/m³	Depending on time of installation and thermal output	Cross-duct	
			SO_2	100-600	mg/m³		NDIR / NDUV for multigas analysis (SO_2, NO_x) CO NH_3 for $DeNO_x$ control as operating parameter with TDLAS / FTIR due to low value expected after emission control	
			NO_x	100-300	mg/m³			
			Hg	0.03	mg/m³		Hot-extractive with Atomic Fluoresence or Atomic Absorption with Zeeman correction	
10	Zinc	Smelter, SRU	PM	75	mg/m³		In-situ	
			SO_2	950-1 250	mg/m³		NDIR / UVF / NDUV	
11	Copper	Smelter, SRU	PM	75	mg/m³		In-situ	
			SO_2	950-1 250	mg/m³		NDIR / UVF / NDUV	
12	Biomedical waste Incinerator	Incinerator Stack	PM	50	mg/m³		In-situ	
			NO_x	400	mg/m³		FTIR, TDLAS, for gases (Hot wet extractive is preferable)	
			HCl	50	mg/m³			
			Hg	0.05	mg/m³		Hot-extractive	
13	Common Hazardous Waste Incinerator	Incinerator Stack	PM	50	mg/m³		In-situ	
			HCl	50	mg/m³		Hot wet extractive FTIR	In-situ TDLAS
			SO_2	200	mg/m³			NDIR
			CO	50	mg/m³	24 h average		
				100	mg/m³	30 min average		
			TOC	20	mg/m³		FID	
			HF	4	mg/m³		Hot wet extractive FTIR	In-situ TDLAS
			NO_x	400	mg/m³			NDIR
			Hg	0.05	mg/m³		Hot-extractive	
14	Sugar	Boiler	PM	150	mg/m³			

Emission monitoring guidelines in the Philippines and in Singapore

Emission monitoring guidelines in the Philippines

Philippine Clean Air Act of 1999
The Philippines Clean Air Act of 1999 was declared to protect and advance the right of the people to a balanced and healthy ecology with the rhythm and harmony of nature. The state under this act promotes and protects the global environment to attain sustainable development while recognizing the primary responsibility of local government units to deal with environmental problems.

Guidelines
The following document can be used for detailed information: Guidelines on the requirements for continuous emission monitoring systems (CEMS) and other acceptable protocols thereby modifying and clarifying certain provisions of section 5, rule X of DAO (DENR Administrative Order) 2000-81 and other related provisions.

The document states i. a. "Continuous Emission Monitoring System" (CEMS) refers to the equipment stipulated in the DAO 2000-81 used to sample, analyze, measure, and provide, by any means of readings recorded at least once every 15 minutes (using an automated data acquisition and handling system), a permanent record of relevant regulated pollutant emissions or stack gas volumetric flow rate.

Another two excerpts from this document make clear that regulations and procedures correlate quite well with US EPA regulations:

- When CEMS is required, quality assurance and quality control procedures shall comply with 40 CFR Part 60 Appendix F (Quality Assurance Procedures).
- Each CEMS shall be audited and conducted in accordance to 40 CFR Part 60 Appendix F.6. Relative Accuracy Test Audit (RATA) must be performed annually by industries.

Emission monitoring guidelines in Singapore

Air quality guidelines
The National Environment Agency NEA implemented a suite of measures to achieve higher national air quality standards by 2020.

Following the acceptance of the implementation, the Ministry of the Environment and Water Resources (MEWR) adopted the World Health Organization (WHO) Air Quality Guidelines (AQG) in 2012 for particulate matter 10 (PM10), nitrogen dioxide, carbon monoxide and ozone, and the WHO AQG's interim targets for PM2.5 and sulfur dioxide.

The reporting frequency by NEA on the Pollutant Standards Index (PSI) which measures five key pollutants namely particulate matter PM10, ozone, nitrogen dioxide, carbon monoxide and sulfur dioxide in the ambient air is three times daily. The daily reports will include PM2.5 as well.

Emission monitoring guidelines in Australia

There are no national wide air emissions standards in Australia. Environment protection authorities in individual states and territories set such standards.

Australian Capital Territory
The Air Environment Protection Policy (Nov 3, 1999) prepared in accordance with the Environment Protection Act 1997 contains information and policies relating to the management of ambient air quality and pollutant emissions to the atmosphere in the ACT. Emission standards for air pollutants from industrial processes outlined in National Guidelines for Control of Emission of Air Pollutants from New Stationary Sources 1985 are adopted in ACT. The guidelines are intended for new plants, and retrospective application to plant and installations or those are already approved and under construction is not intended.

Victoria
The Environment Protection Act 1970 is Victoria's primary environment protection legislation. State environment protection policies (SEPPs) are subordinate legislation made under the provisions of the Act to provide more detailed requirements and guidance for the application of the Act. The air quality management SEPP establishes the framework for managing emissions of air pollutants into the air from all sources in Victoria. The specific air pollutant emission standards are set in Victoria Government Gazette NO.S240, December of 2001.

New South Wales
The Department of Environment and Climate Change (DECC) is the NSW government agency responsible for developing, coordinating and delivering policy and programs to deal with environmental, climate change, sustainability, natural resource and cultural heritage issues in NSW.

The Protection of the Environmental Operations Act 1997 (the POEO Act) provides the legal basis of environment protection regulation across NSW. The Protection of the Environment (Clean Air) Regulation 2002, set emission standards for air pollutants emissions from power plants and industrial processes. This regulation was replaced again by the Clean Air Regulation 2010, which is in force from September 1, 2010.

South Australia
The Environment Protection Authority (EPA) is South Australia's primary environmental regulator. Environment Protection (Air Quality) Policy 1994 (in force from May 1, 1995) set the emission standards for air pollutants from power plants and industrial processes. The Policy was amended in 2005 and the amended Policy became effective from Nov 3, 2005.

Tasmania
The Environment Protection Authority (EPA) in Tasmania, commenced operation on July 1, 2008, is responsible for environmental management and pollution control matters based on the Environmental Management and Pollution Control Act 1994. In Tasmania, emissions from industries are regulated under the general provisions of the Environmental Management and Pollution Control Act 1994 and the Land Use Planning and Approvals Act 1993. The permissible concentrations and/or loads of pollutants present in discharges to the atmosphere from power plants and industrial processes are set in Environment Protection Policy (Air Quality) 2004 (in force from May 1, 2005).

Western Australia/Northern Territory
There is no state wide specific emission standards set by both Western Australia and North Territory.

Emission monitoring guidelines in South Korea and Thailand

Emission monitoring guidelines in South Korea

In South Korea, allowable emission standard for air pollutants emitted from the discharging facility regulates the gaseous substances and the particles separately starting from January 1, 2015.

Allowable emission standard for air pollutants to be applied from the year 2015 will be separately applied by using common applying standard or enforced standard that is to be used in case single emission amount of specified harmful substance exceeds tons per year.

Atmosphere Environmental Standard (Environmental Policy Law Act 2):

Emission limit values in South Korea			
Pollutant	**Limits**		**Recommended measuring method**
SO_2	Yearly average	0.02 ppm	Pulse UV fluorescence method
	24 hrs average	0.05 ppm	
	1 hr average	0.15 ppm	
CO	8 hrs average	9 ppm	Non dispersive infrared method
	1 hr average	25 ppm	
NO_2	Yearly average	0.03 ppm	Chemiluminescence methodw
	24 hrs average	0.06 ppm	
	1 hr average	0.10 ppm	
PM-10	Yearly average	50 µg/m³	ß-ray absorption method
	24 hrs average	100 µg/m³	
PM-25	Yearly average	25 µg/m³	Since Jan 1, 2015, manual method or not specified yet
	24 hrs average	50 µg/m³	
O_2	8 hrs average	0.06 ppm	UV photometric method
	1 hr average	0.1 ppm	
Pb	Yearly average	0.5 µg/m³	Atomic absorption spectrophotometry
Benzene	Yearly average	5 µg/m³	Gas chromatography

Emission monitoring guidelines in Thailand

Thailand is mostly following the EPA guidelines.

Continuous emission monitoring is mandatory for the following production plants:

- Electricity generating > 29 MW
- Boilers or heat source size 30 tons of steam per hour, or > 100 million u/BT per hour
- Cement, lime, plaster in kiln and clinker cooler
- Pulp and paper (recovery furnace, lime kiln digester, brown stock washer, evaporator and condensate stripper system)
- Petroleum
  - Fluid catalytic cracking unit (FCCU)
  - Fuel oil combustion unit
  - Sulfur recovery unit (SRU)
- Steel factories > 100 tons per day
- Copper and zinc factories
- Lead compounds factories
- Incinerators
- Sulfur producing factories

Emission monitoring guidelines in Vietnam and other regions

Emission monitoring guidelines in Vietnam

The country's strategy to manage environmental (including air) pollution from industry and energy sector is embedded in the Decision No. 1855/QD-TTg issued by the Prime Minister on December 27, 2007 (Approving Vietnam's National Energy Development Strategy up to 2020, with 2050 Vision). Some of its objectives are (1) to formulate long-term environmental objectives and standards in conformity with regional and global environmental standards and the country's economic conditions; (2) to control and mitigate environmental pollution in energy-related activities and (3) by 2015, all energy facilities will reach environmental standards.

National technical regulations of ambient air and emission are compiled in 2009/BTNMT according to Circular No. 16/2009/TT-BTNMT October 7, 2009 of Ministry of Natural Resources and Environment.

Applied scopes are prescribed respectively:

- QCVN 05 Ambient air quality
- QCVN 06 Hazardous substances in ambient environment
- QCVN 19 Industrial emission of inorganic substances and dusts
- QCVN 20 Industrial emissions of organic substances
- QCVN 21 Emission of chemical fertilizer manufacturing industry
- QCVN 22 Emission of thermal power industry
- QCVN 23 Emission of cement manufacturing industry

Emission monitoring guidelines in other regions

With increasing urbanization and industrialization, air pollution is an increasing concern also in other parts of the world. Sulfur dioxides, nitrogen oxides and particulate matter emissions have been rising steadily over past decades. "Air Quality Standards" exist in many countries and are categorizes for industrial or commercial and sensitive areas or for vehicular emissions. However, there are different states of implementation to be seen or planned for the near future.

Appendices

List of analyzer conformities with regulations

QAL1 certificates and actual information about approved CEMS and analyzer configurations available at www.siemens.com/SiOS											
Measuring component	Measuring range	Typical technology	CGA Technique			QAL 1 according to EN 15267-3		US EPA compliant	Siemens portfolio	
			Cold-extr.	Hot-extr.	In-situ	CEM system TÜV/ UBA	Measuring device MCERTS / SIRA		CEM system	Measuring device
CO	0 ... 50 mg/m³	NDIR	●				●	●	SET CEM 1, SET CEM CERT, US CEMS version	ULTRAMAT 6
	0 ... 75 mg/m³	NDIR	●			●	●	●	SET CEM 1, SET CEM CERT, US CEMS version	ULTRAMAT 6
	0 ... 100 mg/m³	NDIR	●					●	US CEMS version	ULTRAMAT 6
	0 ... 150 mg/m³	NDIR	●				●		SET CEM 1, SET CEM CERT	ULTRAMAT 6/23
	0 ... 200 mg/m³	NDIR	●			●			SET CEM 1, SET CEM CERT	ULTRAMAT 6/23
	0 ... 250 mg/m³	NDIR	●			●	●		SET CEM 1, SET CEM CERT	ULTRAMAT 6/23
	0 ... 1 000 mg/m³	NDIR	●			●	●	●[1)]	SET CEM 1, SET CEM CERT, US CEMS version[1)]	ULTRAMAT 6/23
	0 ... 1 250 mg/m³	NDIR	●			●	●	●[1)We]	SET CEM 1, SET CEM CERT, US CEMS version[1)]	ULTRAMAT 6/23
	0 ... 3 000 mg/m³	NDIR	●			●	●	●[1)]	SET CEM 1, SET CEM CERT, US CEMS version[1)]	ULTRAMAT 6/23
	0 ... 6 000 mg/m³	NDIR	●			●	●	●[1)]	SET CEM 1, SET CEM CERT, US CEMS version[1)]	ULTRAMAT 6/23
	0 ... 10 000 mg/m³	NDIR	●			●	●	●	SET CEM 1, SET CEM CERT, US CEMS version	ULTRAMAT 6
NO	0 ... 15 mg/m³	UV	●						SET CEM 1, SET CEM CERT	SIPROCESS UV600
	0 ... 15 mg/m³	CLD	●					●	US CEMS version	CLD Analyzer
	0 ... 50 mg/m³	UV	●			●	●		SET CEM 1, SET CEM CERT	SIPROCESS UV600
	0 ... 100 mg/m³	NDIR	●				●		SET CEM 1, SET CEM CERT	ULTRAMAT 23
	0 ... 100 mg/m³	NDIR	●			●	●		SET CEM 1, SET CEM CERT	ULTRAMAT 6
	0 ... 150 mg/m³	NDIR	●			●	●		SET CEM 1, SET CEM CERT	ULTRAMAT 6/23
	0 ... 400 mg/m³	NDIR	●			●	●		SET CEM 1, SET CEM CERT	ULTRAMAT 6/23
	0 ... 600 mg/m³	NDIR	●			●	●		SET CEM 1, SET CEM CERT	ULTRAMAT 6/23
	0 ... 1 000 mg/m³	UV	●			●	●		SET CEM 1, SET CEM CERT	SIPROCESS UV600
	0 ... 1 000 mg/m³	NDIR	●			●	●		SET CEM 1, SET CEM CERT	ULTRAMAT 6/23
	0 ... 2 000 mg/m³	UV	●			●	●		SET CEM 1, SET CEM CERT	SIPROCESS UV600
	0 ... 2 000 mg/m³	NDIR	●			●	●		SET CEM 1, SET CEM CERT	ULTRAMAT 6/23
	0 ... 3 000 mg/m³	NDIR	●			●	●		SET CEM 1, SET CEM CERT	ULTRAMAT 6/23
	0 ... 10 000 mg/m³	NDIR	●			●	●		SET CEM 1, SET CEM CERT	ULTRAMAT 6
NO_2	0 ... 20 mg/m³	UV	●						SET CEM 1, SET CEM CERT	SIPROCESS UV600, ULTRAMAT 23
	0 ... 20 mg/m³	CLD	●						US CEMS version	CLD Analyzer
	0 ... 50 mg/m³	UV	●			●[2)]	●[2)]		SET CEM 1, SET CEM CERT	SIPROCESS UV600, ULTRAMAT 23[2)]
	0 ... 500 mg/m³	UV	●			●[2)]	●[2)]		SET CEM 1, SET CEM CERT	SIPROCESS UV600, ULTRAMAT 23 2)
NO_x	0 ... 20 mg/m³	CLD	●					●	US CEMS version	CLD Analyzer
	see NO ranges x 1.52	NDIR				●	●		SET CEM 1, SET CEM CERT	ULTRAMAT 23 + NOx converter
	via separate NO + NO_2 measurement	UV				●	●		SET CEM 1, SET CEM CERT	SIPROCESS UV600
N_2O	0 ... 50 mg/m³	NDIR	●						SET CEM 1, SET CEM CERT	ULTRAMAT 6

QAL1 certificates and actual information about approved CEMS and analyzer configurations available at www.siemens.com/SiOS											
Measuring component	Measuring range	Typical technology	CGA Technique			QAL 1 according to EN 15267-3		US EPA compliant	Siemens portfolio	
			Cold-extr.	Hot-extr.	In-situ	CEM system TÜV/ UBA	Measuring device MCERTS / SIRA		CEM system	Measuring device
SO_2	0 ... 25 mg/m³	UV	●						SET CEM 1, SET CEM CERT	SIPROCESS UV600, ULTRAMAT 23
	0 ... 50 mg/m³	UV	●			●[2]	●[2]		SET CEM 1, SET CEM CERT	ULTRAMAT 23
	0 ... 75 mg/m³	UV	●			●[2]	●[2]		SET CEM 1, SET CEM CERT	SIPROCESS UV600, ULTRAMAT 23
	0 ... 75 mg/m³	NDIR	●			●	●		SET CEM 1, SET CEM CERT	ULTRAMAT 6
	0 ... 400 mg/m³	NDIR	●			●	●		SET CEM 1, SET CEM CERT	ULTRAMAT 6/23
	0 ... 1 500 mg/m³	NDIR	●			●	●		SET CEM 1, SET CEM CERT	ULTRAMAT 6/23
	0 ... 2 000 mg/m³	NDIR	●			●	●		SET CEM 1, SET CEM CERT	ULTRAMAT 6/23
	0 ... 2 000 mg/m³	UV	●			●[2]	●[2]		SET CEM 1, SET CEM CERT	SIPROCESS UV600, ULTRAMAT 23
	0 ... 7 000 mg/m³	NDIR	●			●	●		SET CEM 1, SET CEM CERT	ULTRAMAT 23
HCl	0 ... 15 mg/m³	TDLS			●	●	●		LDS 6 @ minimum 2 m optical path length	
	0 ... 30 mg/m³	TDLS			●	●	●		LDS 6 @ minimum 1 m optical path length	
	0 ... 90 mg/m³	TDLS			●	●	●		LDS 6 @ maximum 2 m optical path length	
	0 ... 180 mg/m³	TDLS			●	●	●		LDS 6 @ maximum 1 m optical path length	
HF	0 ... 2.5 mg/m³	TDLS			●				LDS 6 @ minimum 2 m optical path length	
	0 ... 180 mg/m³	TDLS			●				LDS 6 @ maximum 1 m optical path length	
NH_3	0 ... 15 mg/m³	TDLS			●	●	●		LDS 6 @ minimum 1.67 m optical path length	
	0 ... 20 mg/m³	TDLS			●	●	●		LDS 6 @ minimum 1.25 m optical path length	
	0 ... 380 mg/m³	TDLS			●	●	●		LDS 6 @ maximum 1.25 m optical path length	
CH_4	0 ... 20 mg/m³	NDIR	●						SET CEM 1, SET CEM CERT	ULTRAMAT 6
TOC	0 ... 15 mgC/m³	FID		●		●	●		SET CEM 1, SET CEM CERT	FIDAMAT 6
	0 ... 500 mgC/m³	FID		●		●	●		SET CEM 1, SET CEM CERT	FIDAMAT 6
Hg	0 ... 45 µg/m³	UV		●		●	●	●	HM-1400 TRX	
	0 ... 75 µg/m³	UV		●		●	●	●	HM-1400 TRX	
Dust/ opacity	0 ... 15 mg/m³	Various			●	●	●	●	D-R 290/320/808, D-RX 250	
Formaldehyde	0 ... 20 mg/m³	Various							On request, Project specific	
	0 ... 90 mg/m³									
Reference values										
O_2	0 ... 25 Vol%	Paramag.	●			●	●	●[1]	SET CEM 1, SET CEM CERT, US CEMS version[1]	OXYMAT 6, ULTRAMAT 23
	0 ... 25 Vol%	Electrochem.	●			●	●		SET CEM 1, SET CEM CERT	ULTRAMAT 23
	0 ... 25 Vol%	(TDLS) NDIR			●				LDS 6, SITRANS SL	
H_2O	0 ... 30 Vol%	TDLS			●	●	●		LDS 6 @ 1.25 m optical path length	
	0 ... 50 Vol%	TDLS			●	●	●		LDS 6 @ maximum 1 m optical path length	
CO_2	0 ... 25 Vol%	NDIR	●			●	●		SET CEM 1, SET CEM CERT	ULTRAMAT23
	0 ... 25 Vol%	NDIR	●						SET CEM 1, SET CEM CERT	ULTRAMAT 6
	0 ... 25 Vol%	(TDLS) NDIR			●				LDS 6	
Velocity/ vol. flow	3 ... 30 m/s				●	●	●	●	D-FL 100/220, D-RX 250	
T					●				SITRANS T	
p					●				SITRANS P	
Emission data management systems										
Emission data						●	●	●	D-EMS 2000, D-EMS 2020	
management systems						●[3]			Siemens Austria solution (Emidate)	

1) US EPA compliance for US CEMS version with ULTRAMAT 6 and/or OXYMAT 6
2) For ULTRAMAT 23 ongoing QAL 1 activities (Status: June 2018)
3) QAL 1 approval according to Austrian Standards, by TÜV Austria

Application questionnaires for CEM applications and other services for gas analysis from Siemens Process Analytics

Application questionnaires for CEM applications

Siemens Process Analytics has extensive experience in planning, engineering and manufacturing of analytical systems including CEMS. From single standard analyzer to customized systems, we can provide a solution that will meet your specific requirements.

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Some examples

Process efficiency
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