Continuous Emissions Monitoring (CEMS)

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Presented to AWMA – Las Vegas Chapter

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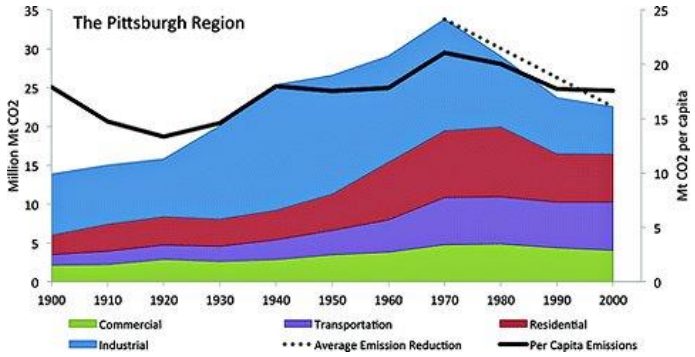
Cal-Bay Controls

October, 2019

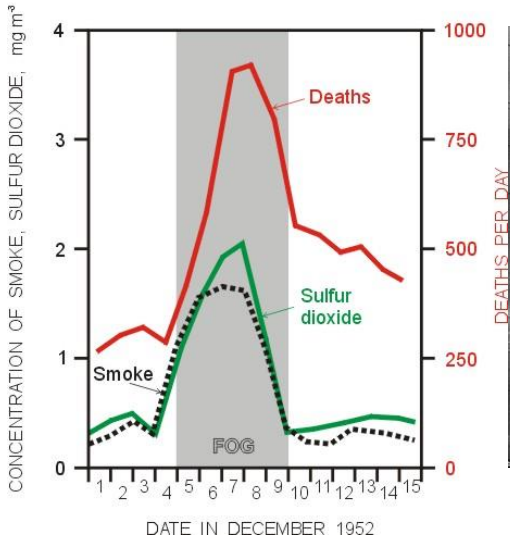
Definitions

- **CEMS = Continuous Emissions Monitoring System**
- **Compliance CEMS = used to meet regulatory agency requirements USEPA/State/Local**
- **DAS = Data Acquisition System**
- **Ambient Monitoring System = monitoring of ambient air quality**
- **Process or Control CEMS = used to provide information to improve plant operations**

Air Pollution (Smog)



THE LONDON SMOG



Air Monitoring Regulations History

- **1955 - Air Pollution Control Act provided research funds to study air quality**
- **1963 - US Congress passed Clean Air Act (CAA) to provide additional funding into air pollution study and control**
- **1965 - Motor Vehicle Air Pollution Control Act for mobile sources of air pollution**
- **1967 - Air Quality Act for stationary sources**
- **1970 - CAA amended and significantly expanded with administration and enforcement delegated to USEPA which was formed in December 1970**

Air Monitoring Regulations History

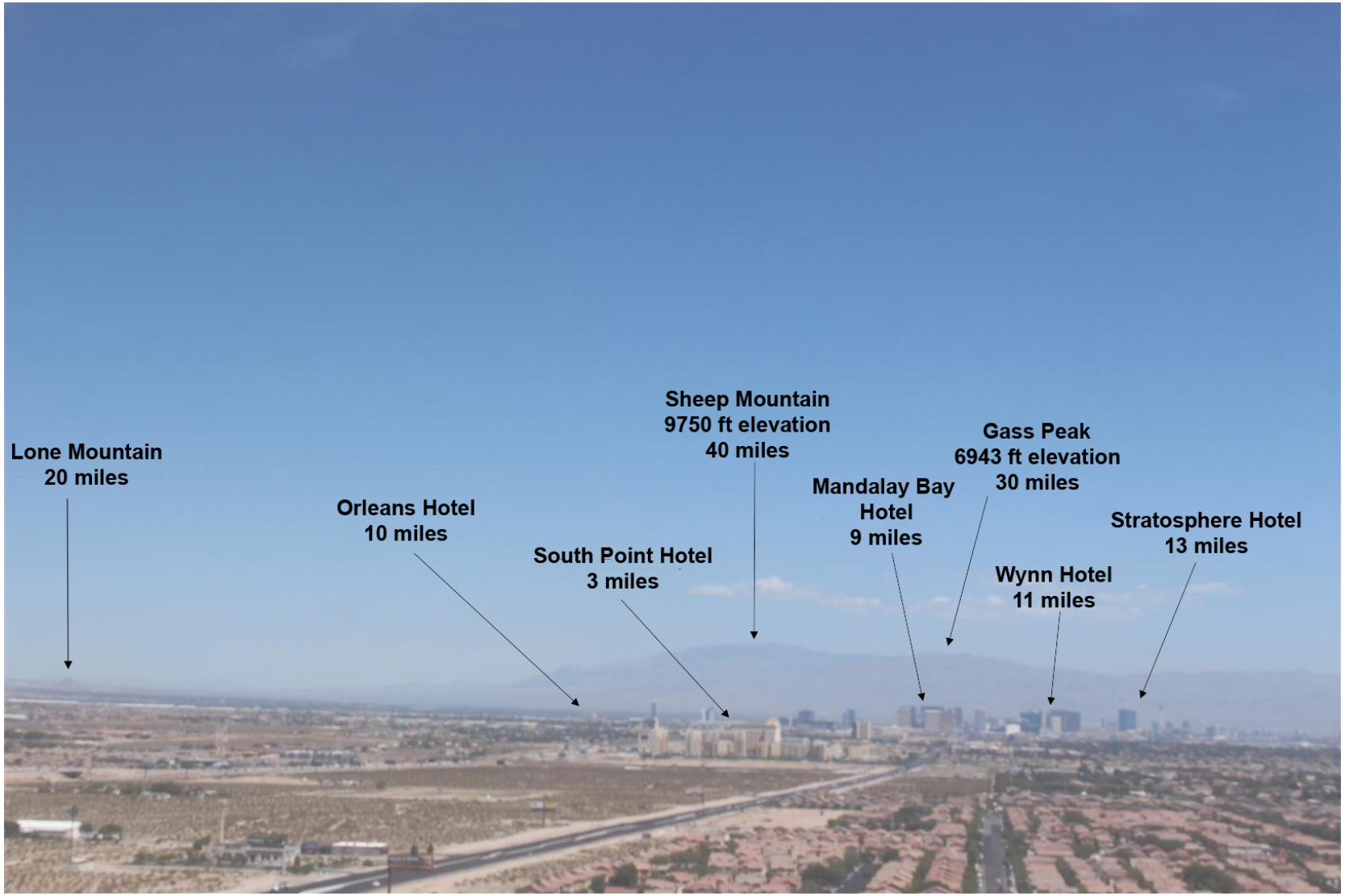
- **The 1970 Clean Air Act requires EPA to set national ambient air quality standards (NAAQS) for specific pollutants to safeguard human health and the environment. These standards define the levels of air quality that EPA determines are necessary to protect against the adverse impacts of air pollution based on scientific evidence. EPA has established standards for six common air pollutants, which are referred to as "criteria" pollutants.**

  - **Nitrogen dioxide (NO_2)**
  - **Carbon monoxide (CO)**
  - **Sulfur dioxide (SO_2)**
  - **Ozone (O_3)**
  - **Particulate matter (PM)**
  - **Lead (Pb)**

Clark County Department Of Air Quality

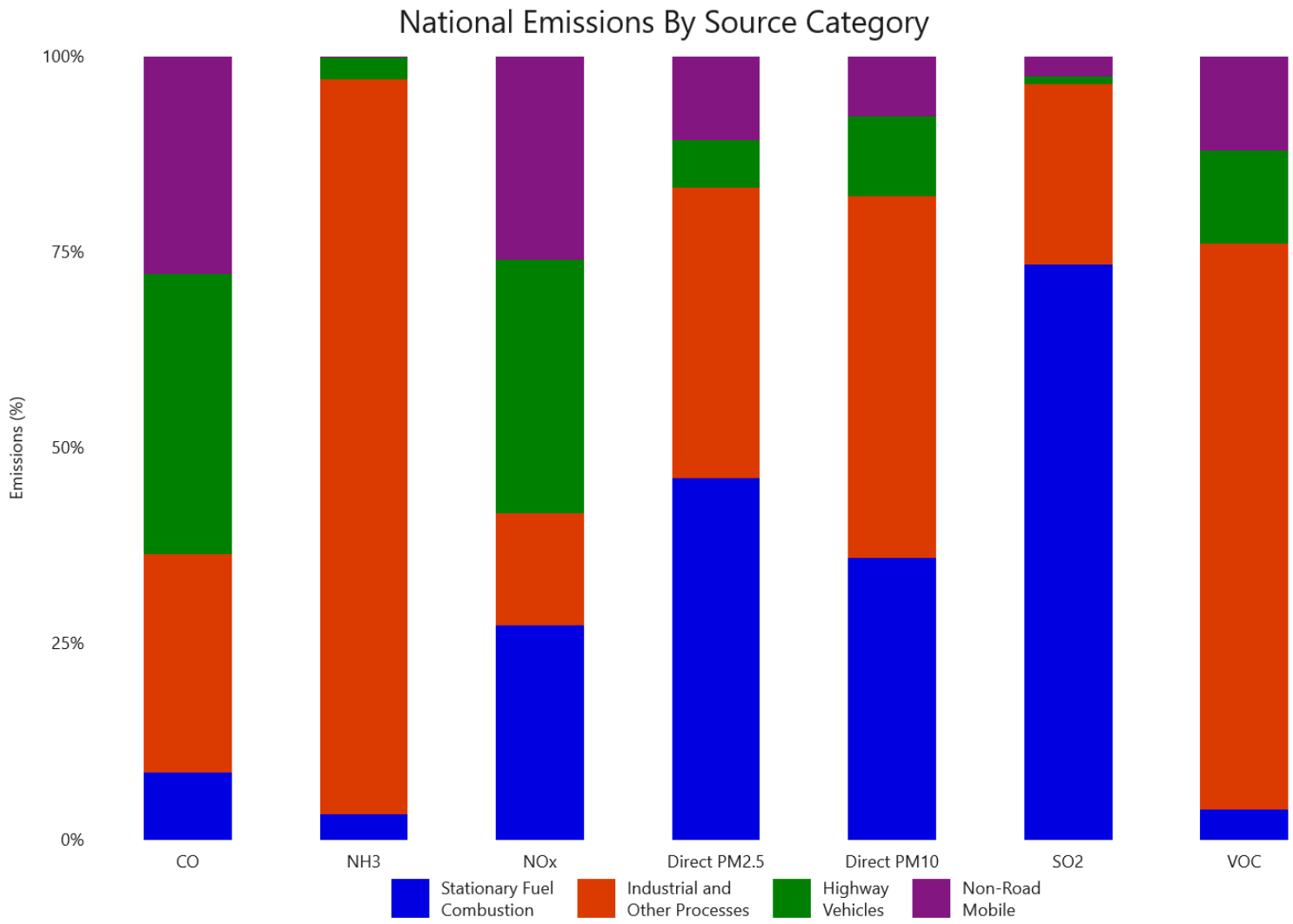
Ambient Air Monitoring Site Information

CAMS	EPA Site	Site Description	Street Address	City	AQI Metro Area	Responsible Entity
22	32-003-0022	Apex	12101 Hwy 91, Nevada Las Vegas, NV 89165	Apex	Apex	Clark County Department of Air Quality
601	32-003-0601	Boulder City	1005 Industrial Road	Boulder City	Boulder City	Clark County Department of Air Quality
298	32-003-0298	Green Valley	298 North Arroyo Grande	Henderson	Greater Las Vegas	Clark County Department of Air Quality
7772	32-003-7772	Indian Springs	668 Gretta Ln	Indian Springs	Indian Springs	Clark County Department of Air Quality
1019	32-003-1019	Jean	1965 State Hwy 161	Jean	Jean	Clark County Department of Air Quality
43	32-003-0043	Paul Meyer	4525 New Forest Dr.	Las Vegas	Greater Las Vegas	Clark County Department of Air Quality
71	32-003-0071	Walter Johnson	7701 Ducharme Dr.	Las Vegas	Greater Las Vegas	Clark County Department of Air Quality
73	32-003-0073	Palo Verde	126 S. Pavilion Center Dr.	Las Vegas	Greater Las Vegas	Clark County Department of Air Quality
75	32-003-0075	Joe Neal	6076 Rebecca	Las Vegas	Greater Las Vegas	Clark County Department of Air Quality
540	32-003-0540	Jerome Mack	4250 Karen Ave	Las Vegas	Greater Las Vegas	Clark County Department of Air Quality
561	32-003-0561	Sunrise Acres	2501 South Sunrise Avenue	Las Vegas	Greater Las Vegas	Clark County Department of Air Quality
1501	32-003-1501	Rancho & Teddy	2755 South Rancho Drive	Las Vegas	Greater Las Vegas	Clark County Department of Air Quality
1502	32-003-1502	Casino Center	500 N. Casino Center Boulevard	Las Vegas	Greater Las Vegas	Clark County Department of Air Quality
7771	32-003-7771	SM Youth Camp	Ries RD.	Las Vegas	Spring Mountain	Clark County Department of Air Quality
8000	32-003-8000	Las Vegas Paiute	off Paiute Way	Las Vegas	Paiute Tribe	Paiute
9995	32-003-9995	Gravimetric Laboratory	4701 West Russell Rd	Las Vegas		Clark County Department of Air Quality
23	32-003-0023	Mesquite	465 East Old Mill Road	Mesquite	Mesquite	Clark County Department of Air Quality


Lone Mountain
20 miles
Orleans Hotel
10 miles
South Point Hotel
3 miles
Sheep Mountain
9750 ft elevation
40 miles
Mandalay Bay
Hotel
9 miles
Gass Peak
6943 ft elevation
30 miles
Wynn Hotel
11 miles
Stratosphere Hotel
13 miles

Understanding Emission Sources

Generally, emissions of air pollution come from:
•stationary fuel combustion sources (such as electric utilities and industrial boilers),
•industrial and other processes (such as metal smelters, petroleum refineries, cement kilns and dry cleaners),
•highway vehicles, and
•non-road mobile sources (such as recreational and construction equipment, marine vessels, aircraft and locomotives).
As the chart shows, pollutants are emitted by a variety of sources. For example, electric utilities, part of the stationary fuel combustion category, release SO_2, NO_x and particles.



Air Monitoring Regulations History

- **1970 to present – EPA regulations promulgated to reduce air emissions from stationary and mobile sources**
- **CAA new source performance standards (NSPS) define amount of pollution allowed by stationary sources**
- **40CFR60 Subparts define Continuous Emissions Monitoring System requirements for different sources**
- **40CFR60 Appendix F define CEMS Quality Assurance requirements**
- **40CFR75 define additional CEMS requirements under USEPA Acid Rain program**
- **EPA delegates authority for permitting and compliance with CEMS regulations to States**

Examples of 40CFR60 Subparts:

(most common Subparts that include CEMS requirements)

Electric Utility Steam Generating Units (Boilers)	40 CFR 60 Subpart Da
Industrial/Commercial/Institutional Steam Generating Units (Boilers)	40 CFR 60 Subpart Db - Dc
Portland Cement Manufacturing	40 CFR 60 Subpart F
Stationary Gas Turbines	40 CFR 60 Subpart GG
Stationary Compression Ignition Internal Combustion Engines	40 CFR 60 Subpart IIII
Stationary Combustion Turbines	40 CFR 60 Subpart KKKK

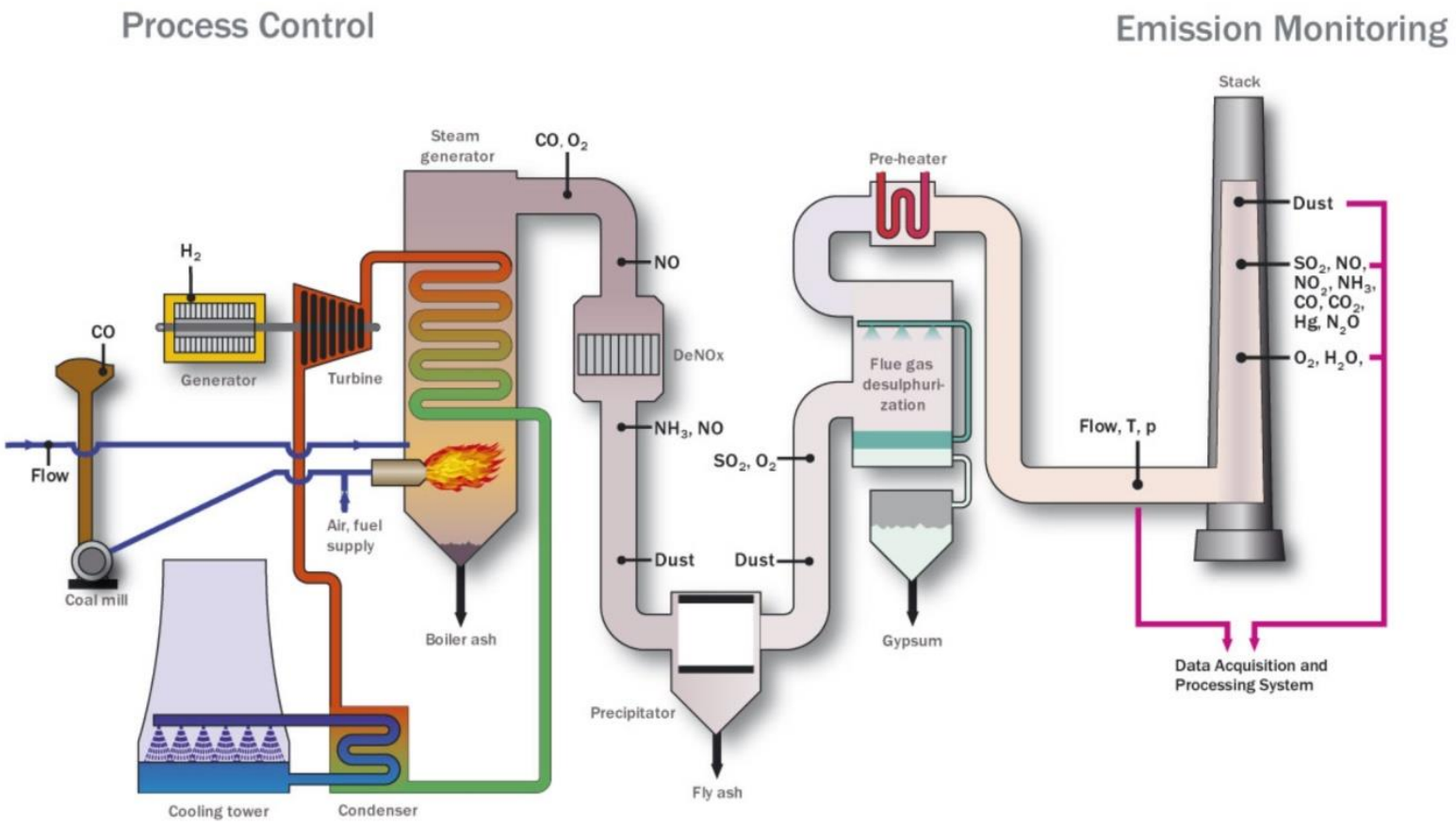
Rules and Regulations:

Section 12.0 - Applicability and General Requirements - Amended 12-18-18 (Ordinance 4189); EPA approval effective 11-17-14 (79 FR 62350)
Section 12.1 - Permit Requirements For Minor Sources - Amended 12-18-18 (Ordinance 4189); EPA approval effective 11-17-14 (79 FR 62350)
Section 12.2 - Permit Requirements For Major Sources In Attainment Areas (Prevention Of Significant Deterioration) - Amended 03-18-14 (Ordinance 4189); EPA approval effective 11-17-14 (79 FR 62350)
Section 12.3 - Permit Requirements For Major Sources In Nonattainment Areas - Amended 03-18-14 (Ordinance 4189); EPA approval effective 11-17-14 (79 FR 62350)
Section 12.10 - Continuous Monitoring Requirements for Stationary Sources - Adopted 03-16-10, Effective 07-01-10
Section 14 - New Source Performance Standards - Amended 09-04-18 (Ordinance 4264), Effective 09-18-18
Section 21 - Acid Rain Permits - Amended 07-01-04
Section 22 - Acid Rain Continuous Emission Monitoring - Amended 07-01-04

Typical stationary sources requiring CEMS:

- Electric-Generating Power Plants
  - Utility Power Plants
- Cogeneration/CHP Plants
  - Independent power production
  - Any facility with on-site plant for combined hear and power
    - Universities
    - Hospitals
- Cement kilns
- Petroleum Refineries
- Any facility with combustion or process that generates regulated emissions

Typical Power Plant Process and Compliance Monitoring



So What is a “CEMS”?

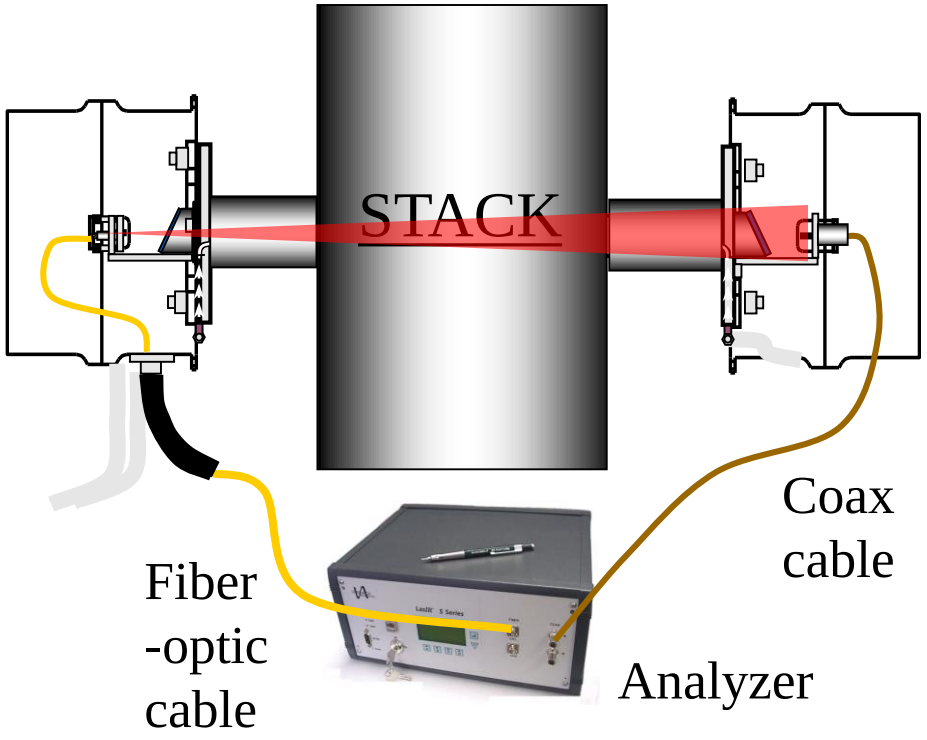
- **A CEMS is a monitoring device or monitoring system that measures the air emissions from a stationary source on a continuous or near-continuous basis**
- **Types of CEMS:**
  - **In-Situ**
  - **Extractive**
- **In-Situ:**
  - **In stack, point measurement**
  - **Across stack monitor**
  - **“Close-coupled” Ex-situ monitor**
- **Extractive:**
  - **“Dilution” extractive**
  - **“Fully-extractive”**

In-Situ CEMS

- **In-Stack (or duct) point monitor**
  - **Usually a sensor inserted directly into the sample stream or a sensor placed “ex-situ” immediately outside the stack wall**
  - **Sensor subject to temperature, pressure, moisture, possible high levels of particulates and/or acid gases**
  - **Difficult to service**
  - **May not be accurate enough to pass QA tests**
  - **More often used for process monitoring (CO/O2/CO2)**
- **Cross stack monitor**
  - **Use transmitters/receivers on both sides of stack/duct to make measurement**
  - **Examples: opacity, tunable diode laser (TDL), IR/NIR/FTIR**

In-Situ “point” monitor

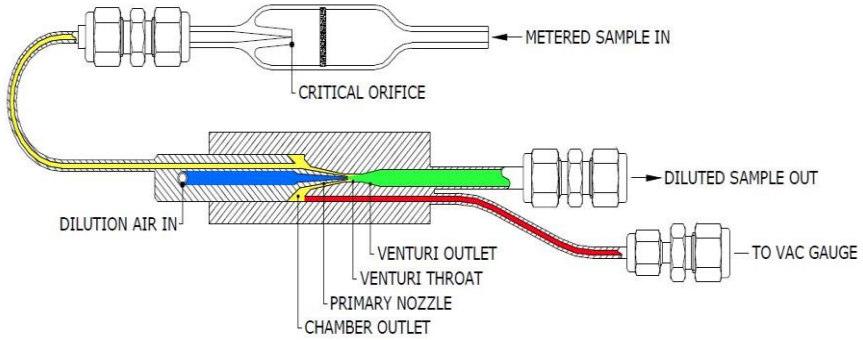
Cross stack In-Situ monitor

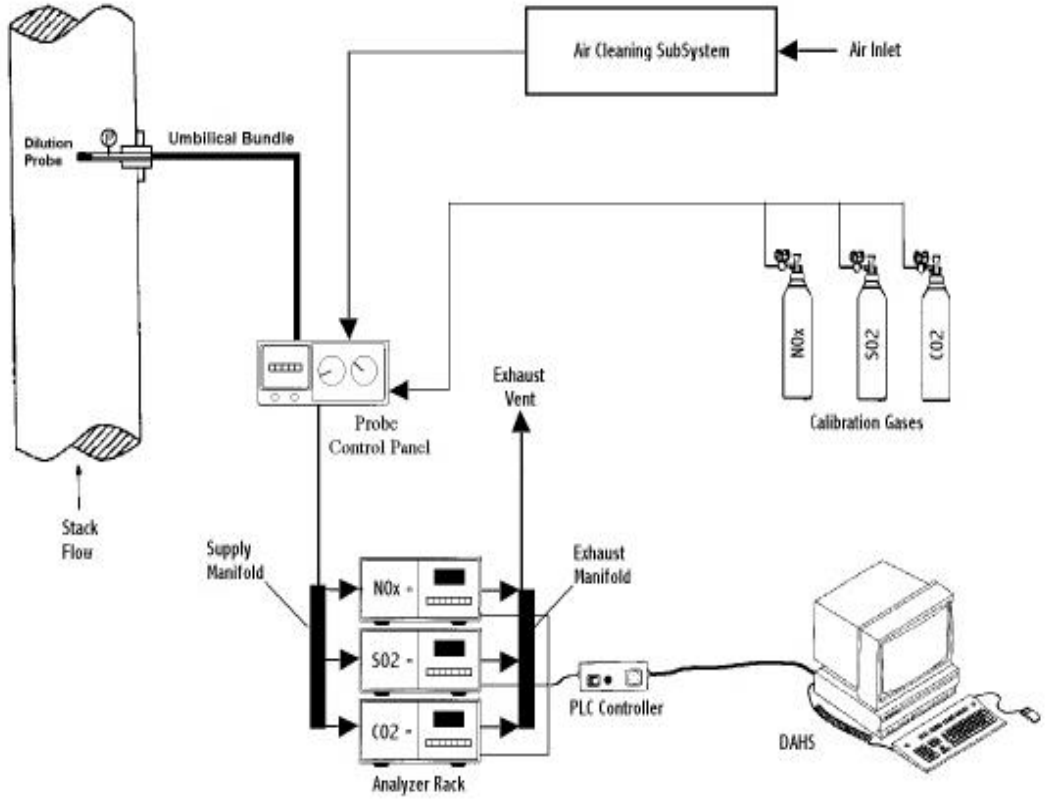


Extractive CEMS

- **Dilution Extractive**
  - **Uses dilution sample probe or device to extract the sample from the stack and immediately dilute sample with clean, dry instrument air to reduce contamination from particulates and moisture… measurement on "wet basis"**
  - **Sample transported to analyzers via low-temperature freeze-protected sample line**
  - **Analyzers located in environmentally controlled location**
  - **Ambient level gas analyzers used to measure lower concentrations of gas pollutants due to dilution**
  - **Data Acquisition System calculates and reports correct emissions concentrations based on dilution ratio**
  - **Advantage: proven design, makes measurement of emissions in dirty, wet sample easier**
  - **Disadvantage: requires use of ambient or trace level analyzers, may not be suitable for application with low emissions levels**

Typical Dilution Extractive CEMS System

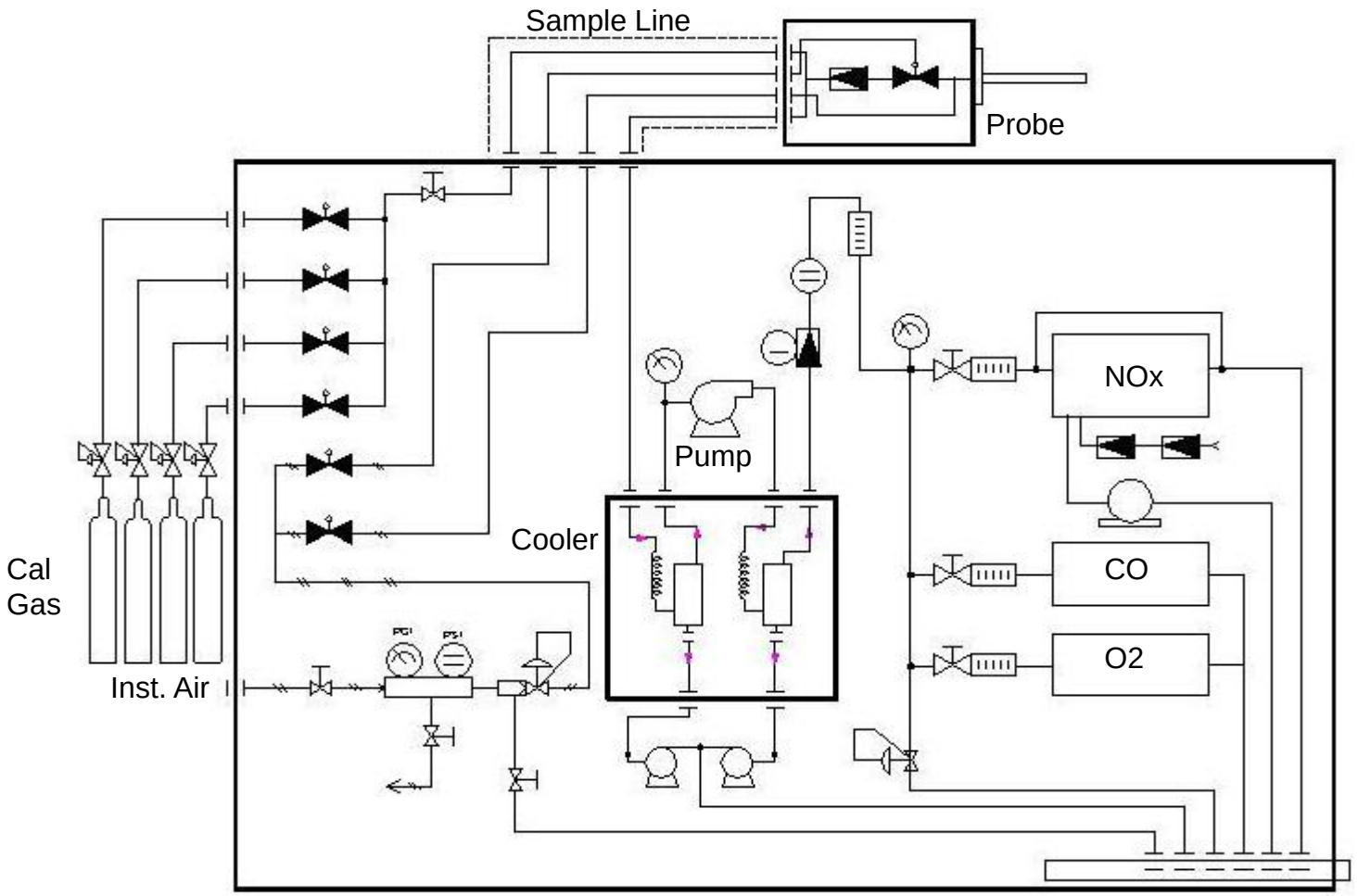




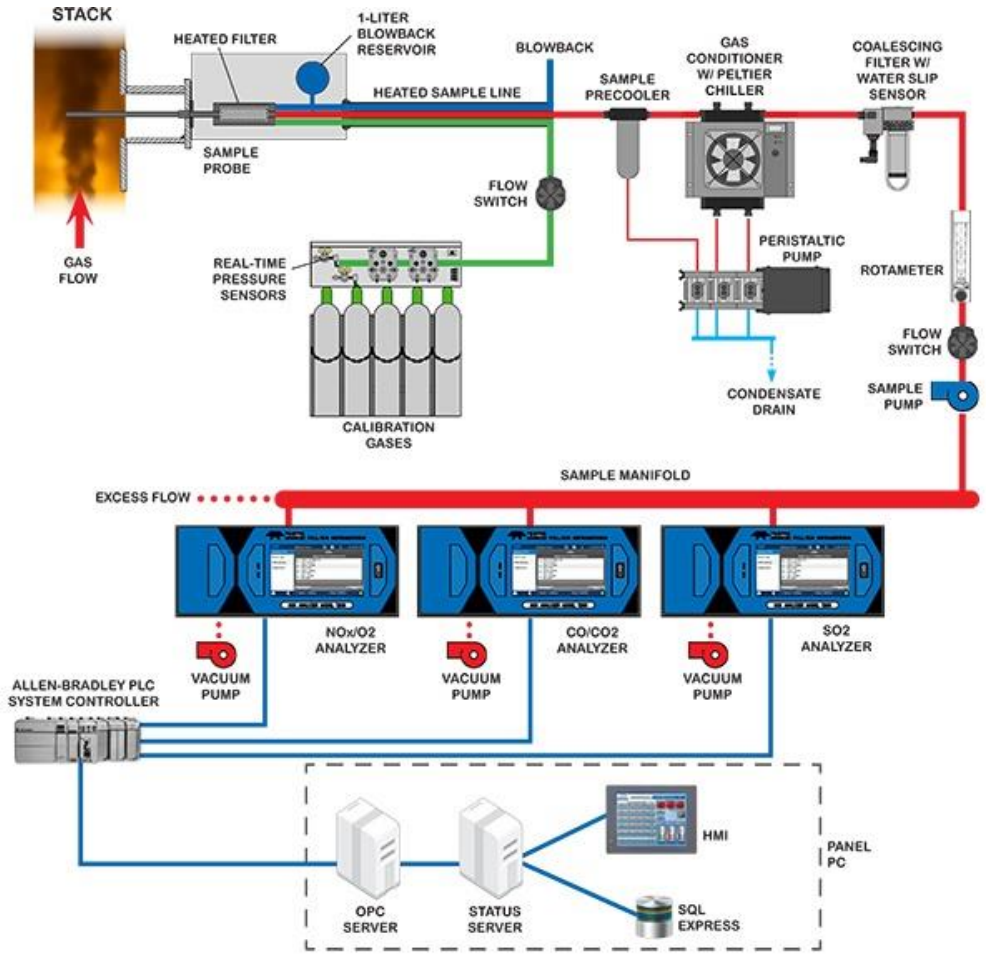
Extractive CEMS

- **Fully-extractive**
  - **Uses sample probe to draw sample from stack without changing sample**
  - **Sample probe has filter to remove most particulates**
  - **Sample transported to analyzers via heat-traced sample line to prevent moisture condensation**
  - **Chiller or condensate removal device used to reduce sample temperature quickly resulting in condensation of water which is removed from sample… measurement on “dry” basis**
  - **Clean dry sample gas sent to gas analyzers for measurement**
  - **Data Acquisition System stores and reports emissions**
  - **Advantages: proven design, flexibility**
  - **Disadvantages: have to maintain sample temperature with heated sample line, may not be suitable for applications with high level of particulates and/or moisture**

Typical Fully Extractive CEMS Flow Schematic



Typical Fully Extractive CEMS Flow Schematic



SAMPLE PROBE WITH HEATED FILTER

CEMS IN NEMA ENCLOSURES

CEMS Analyzers

- **CEMS Analyzers typically are the same technology approved by USEPA for use in ambient air monitoring**
  - **NOx: Chemiluminescent**
  - **SO2: UV Fluorescence**
  - **CO: Gas Filter Correlation InfraRed (GFC IR)**
  - **CO2: Non-Dispersive InfraRed (NDIR)**
  - **O2: Paramagnetic**

- **Permits for some sources include requirements for NH3 or HCL or THC or VOC's**
  - **NH3: Tunable Diode Laser (TDL)**
  - **HCL: TDL, FTIR**
  - **THC: Flame Ionization Detector (FID)**
  - **VOC: Gas Chromatograph (GC), FTIR**

(Many analytical technologies exist… the best choice is determined by the required accuracy, the measurement detection levels, potential interferences, ease of use and maintenance, cost, etc.)

Typical Analyzers in Extractive CEMS Systems

SHELTER INSTALLATION

CEMS in Shelter
in Refinery Application
to meet Classified Area Requirements

CEMS Quality Assurance

- **CEMS QA Requirements**
  - **Initial Certification of CEMS**
    - **Response time tests**
    - **Seven-day Drift Test**
    - **Relative Accuracy Test Audit (RATA) performed by qualified test contractor**
  - **Daily Calibrations of entire CEMS**
    - **Span and zero gases injected into sample probe**
  - **Quarterly Audits**
    - **Cal Gas Audit (CGA) with different span gas concentrations**
  - **Annual Re-Certification**
  - **Additional site-specific requirements**

New Technologies

- **AeroCEMS - drone based sensors**

Our Nation's Air

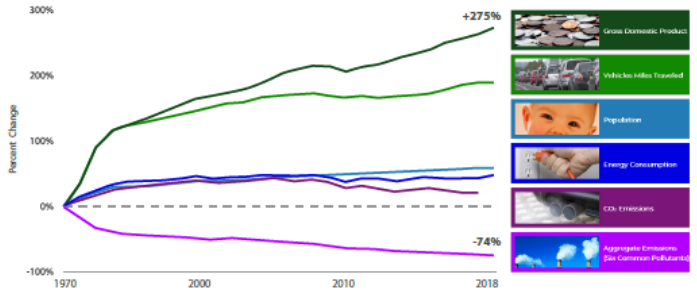
Air Quality Improves as America Grows

https://gispub.epa.gov/air/trendsreport/2019

Economic Growth with Cleaner Air

Between 1970 and 2018, the combined emissions of the six common pollutants ($PM_{2.5}$ and PM_{10}, SO_2, NO_X, VOCs, CO and Pb) dropped by 74 percent. This progress occurred while the U.S. economy continued to grow, Americans drove more miles and population and energy use increased.

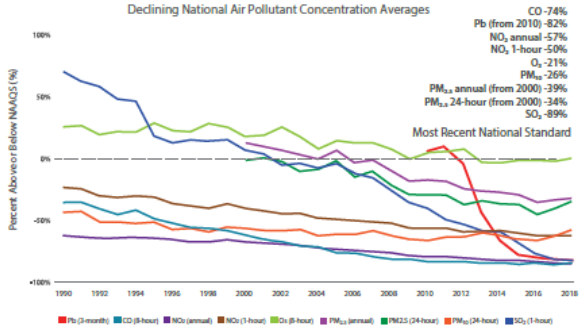
Comparison of Growth Areas and Declining Emissions
1970-2018



Air Quality Trends Show Clean Air Progress

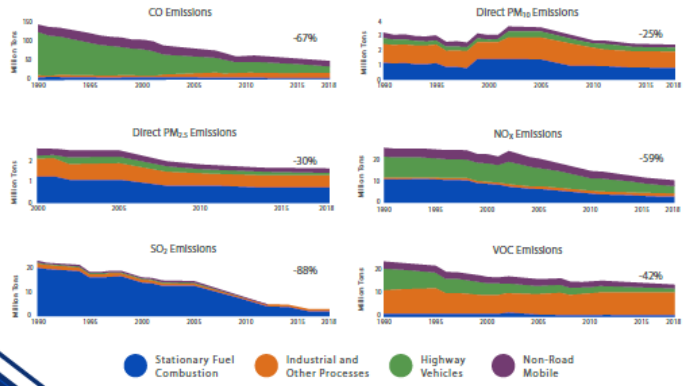
While some pollutants continue to pose serious air quality problems in areas of the U.S., nationally, criteria air pollutant concentrations have dropped significantly since 1990 improving quality of life for many Americans. Air quality improves as America grows.

Declining National Air Pollutant Concentration Averages



Air Pollutant Emissions Decreasing

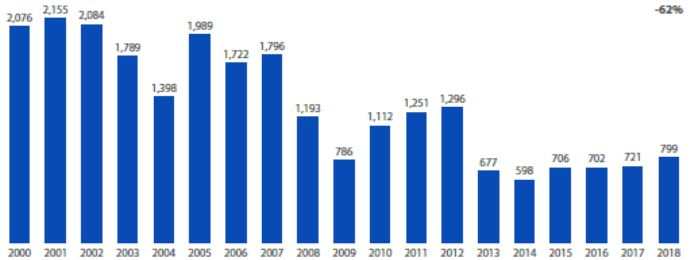
Emissions of key air pollutants continue to decline from 1990 levels. These reductions are driven by federal and state implementation of stationary and mobile source regulations.



Unhealthy Air Days Show Long-Term Improvement

The Air Quality Index (AQI) is a color-coded index EPA uses to communicate daily air pollution for ozone, particle pollution, NO_2, CO, and SO_2. A value in the unhealthy range, above national air quality standard for any pollutant, is of concern first for sensitive groups, then for everyone as the AQI value increases. Fewer unhealthy air quality days means better health, longevity, and quality of life for all of us.

Number of Days Reaching "Unhealthy for Sensitive Groups" Level or Above on the Air Quality Index
(Among 35 Major U.S. Cities for Ozone and $PM_{2.5}$ Combined)



Unhealthy air quality days vary year to year, influenced not only by pollution emissions but also by natural events, such as dust storms and wildfires, and variations in weather.

Status and Trends Through 2018

* Thank You *

- Questions????

- For additional information, please contact us:

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Cal-Bay Controls – Sales Representatives

Teledyne-API
SO2, H2S, TRS, NO/NO2/NOx, "Direct NO2", NOy, CO, CO2, O3, O2 gas analyzers
for ambient monitoring and emissions monitoring for regulatory compliance
Calibrators and Zero-Air Generators
Particulate Monitors for PM2.5, PM10, PM Coarse (PM10-PM2.5) and Ultrafines

Cemtek Environmental or CEMS-Experts
Continuous Emissions Monitoring Systems (CEMS) for compliance with USEPA 40CFR60, 40CFR75, state and local regulatory requirements
Ambient Air Quality monitoring systems
Process monitoring systems for process control and improved efficiency
Data Acquisition and Handling Systems (DAHS)
CEMS Upgrades and Maintenance Service

M&C TechGroup
Gas Sample Probes for CEMS (dilution, fully-extractive and multi-point)
Sample filters, pumps, fittings and heat-traced sample line
Sample Chillers and Conditioning Systems
O2 analyzers
"AirOptic" In-Situ Cross Stack NIR, MIR, IR Monitors
"GasEye" Open-Path Fenceline Monitors

Ametek/MOCON-Baseline
THC, M/NMHC gas analyzers using FID technology
C1-C6, VOC, BTEX, ETO, Toxic gas analyzers using GC technology

EMRC
Pitot tube and Annubar flow monitors

EMS Brüel & Kjær
Noise, Vibration, Dust and Air Quality instruments with Sentinel data management

Charge Bliss
Energy Management Products and Technologies
Microgrids, Solar, Fuel Cells, Batteries, EV Chargers, LED Lighting, EMS, Smart Controllers