Monitoring Exposure to Diesel Particulate Matter and Gases

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Measuring contaminants provides important information.

- Individual personal exposures
- Workplace contaminant levels
- A measure of effectiveness of control measures
- Where and what corrective action needs to be done

Contaminants to be measured

- DPM (as elemental carbon or total carbon)
- Carbon Monoxide, Nitric Oxide, and Nitrogen Dioxide (CO, NO, and NO_2)
- What about carbon dioxide, CO_2?

Current practice

- Typically, full shift personal exposures (PE) to DPM only are done.

- Spot checks of work areas are made for the gases.

Why is this the case?

What are the value and limitations of these typical measurements?

Are they sufficient to control exposures?

Measurement technology has dictated current practice

- DPM can only be reliably measured by full shift sampling
- Historically, stain tubes have been used to get spot measurements of local concentrations of gases

Information obtained by full shift personal exposure is limited

- Little information on where exposure occurs
- DPM exposure results not available for weeks
- Exposure measurements are “after the fact”
- Useful as verification or quality assurance

Modern real-time monitoring instruments can provide more useful information

- Time history (intervals of a minute or less) of gas concentrations
- Can be correlated with location or events
  - Path of vehicle or person
  - Changing work activity (vehicles) in a fixed location
- Locate areas of high concentration
  - Limit working times
  - Make engineering changes to reduce levels

Modern measurement instrumentation is available for the gases, not so for DPM (yet)

Industrial Scientific iTX

CO, NO, NO_2, O_2, Comb.

Vaisala GM-70 CO_2

Real-time log of concentrations

Alarms

Provides Time Weighted Average (iTX)

Recap of “personal” exposure monitoring

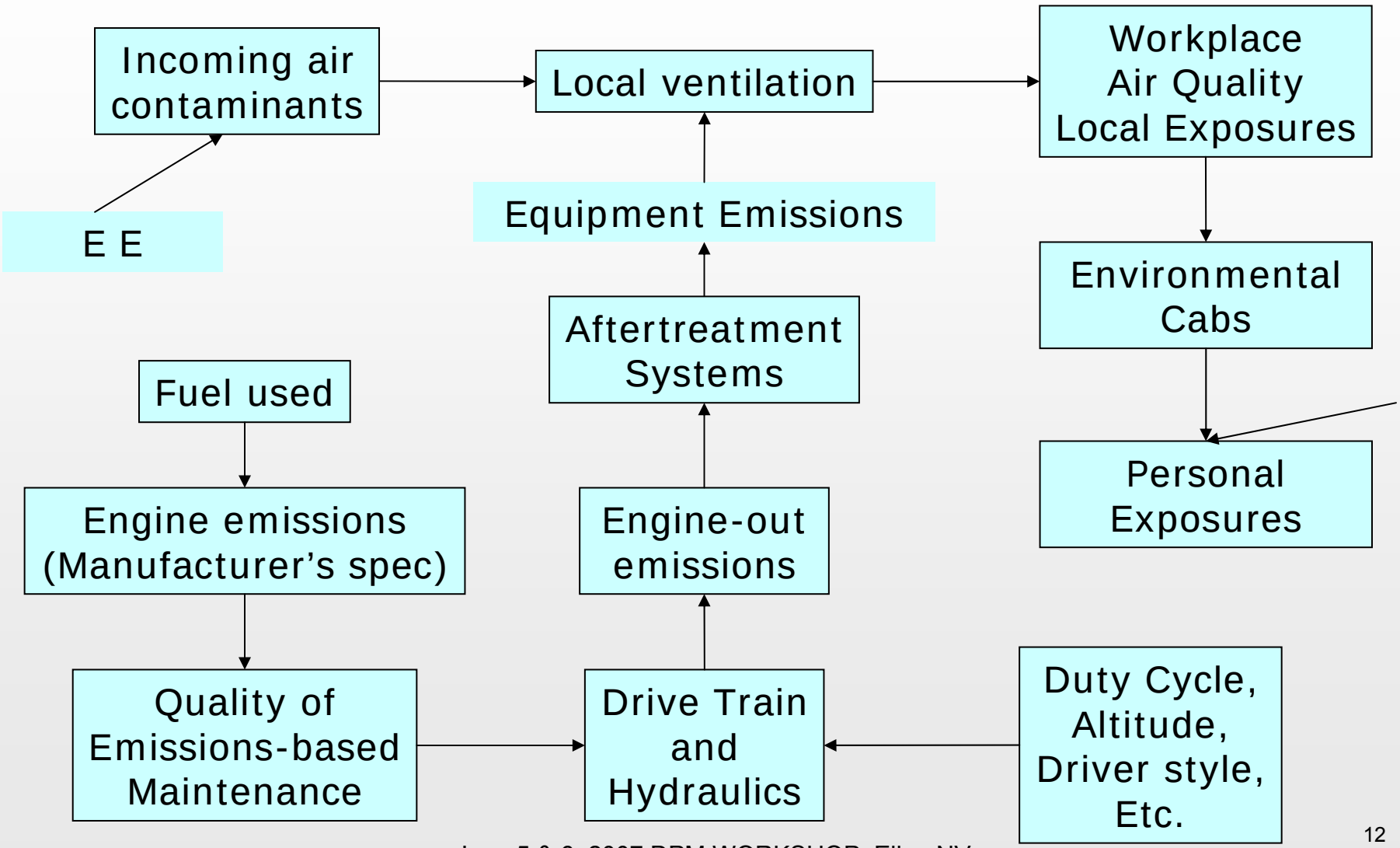
- DPM: single number average for time period of sampling
- Gases: Time history of gas levels which can be correlated with location
- Results are after the fact but useful as verification or identifying problem areas
- Hinted that it might be useful
  - To monitor CO_2
  - To monitor gases and DPM at a fixed location

Monitoring is a fundamental element of an exposure control strategy

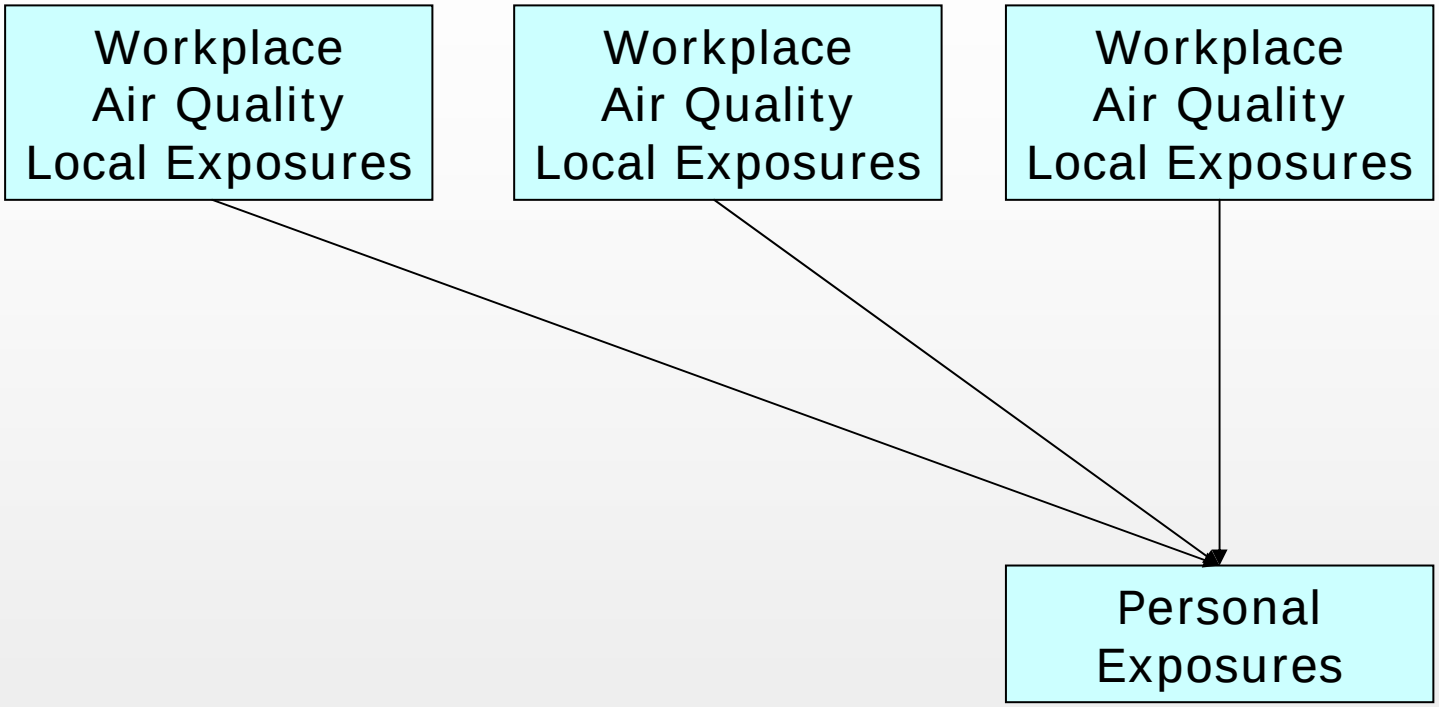
- Diesels + Ventilation = air contaminant factory
- Health standards = final product specifications
- Monitoring
  - Final product quality
  - Indicate where process is going wrong
  - Indicate what needs to be changed

Where and how should monitoring be performed to achieve control of air quality?

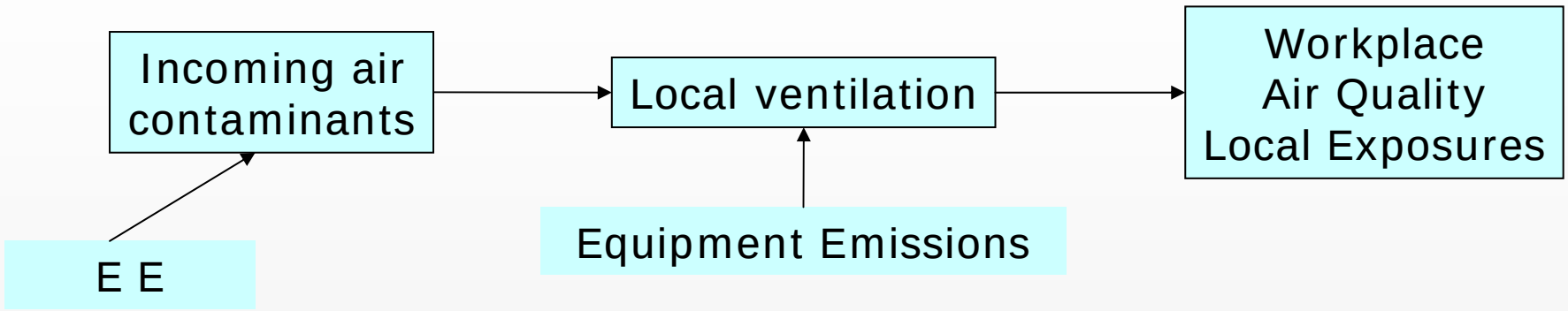
Factors Affecting Workplace Air Quality and Personal Exposures



Total personal exposure results from working and traveling in multiple locations.

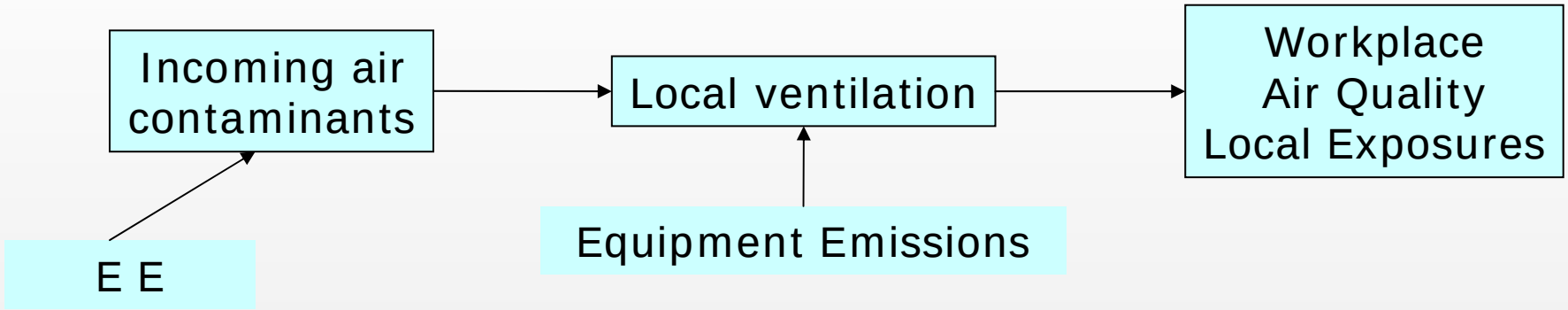


Local workplace contaminant levels result from multiple sources



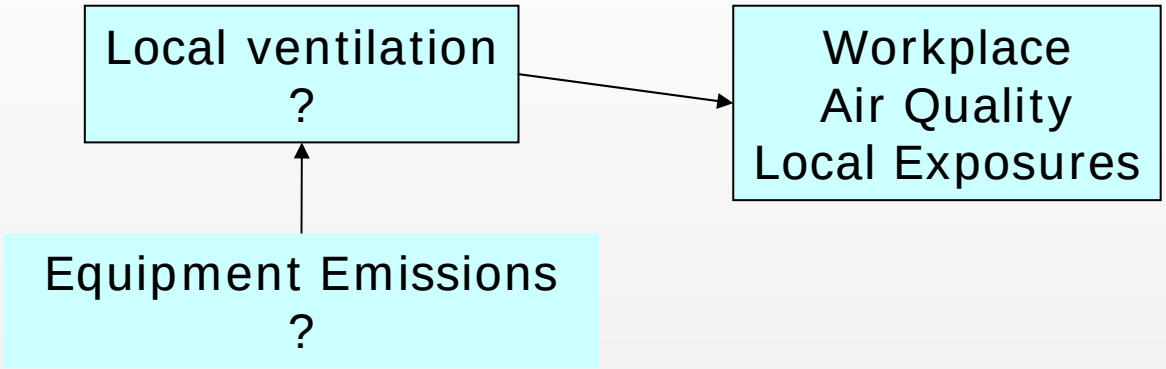
- Elevated DPM and toxic gas levels at the workplace can be a combined result of
  - Elevated level in the air used to ventilate the area
  - Insufficient ventilation air quantity or distribution for the number of vehicles in the area or air split
  - Elevated emission of DPM/gas from one or more pieces of equipment

Measuring DPM and gas levels in incoming air while measuring them in the workplace is necessary to isolate the workplace contaminants to local causes.



DPM/gas at workplace – DPM/gas of incoming air = contribution of local equipment (as diluted by incoming air) to local concentrations

Are the net contaminant levels the result of a lack of air quantity (for the number of equipment in area) or of elevated engine emissions?

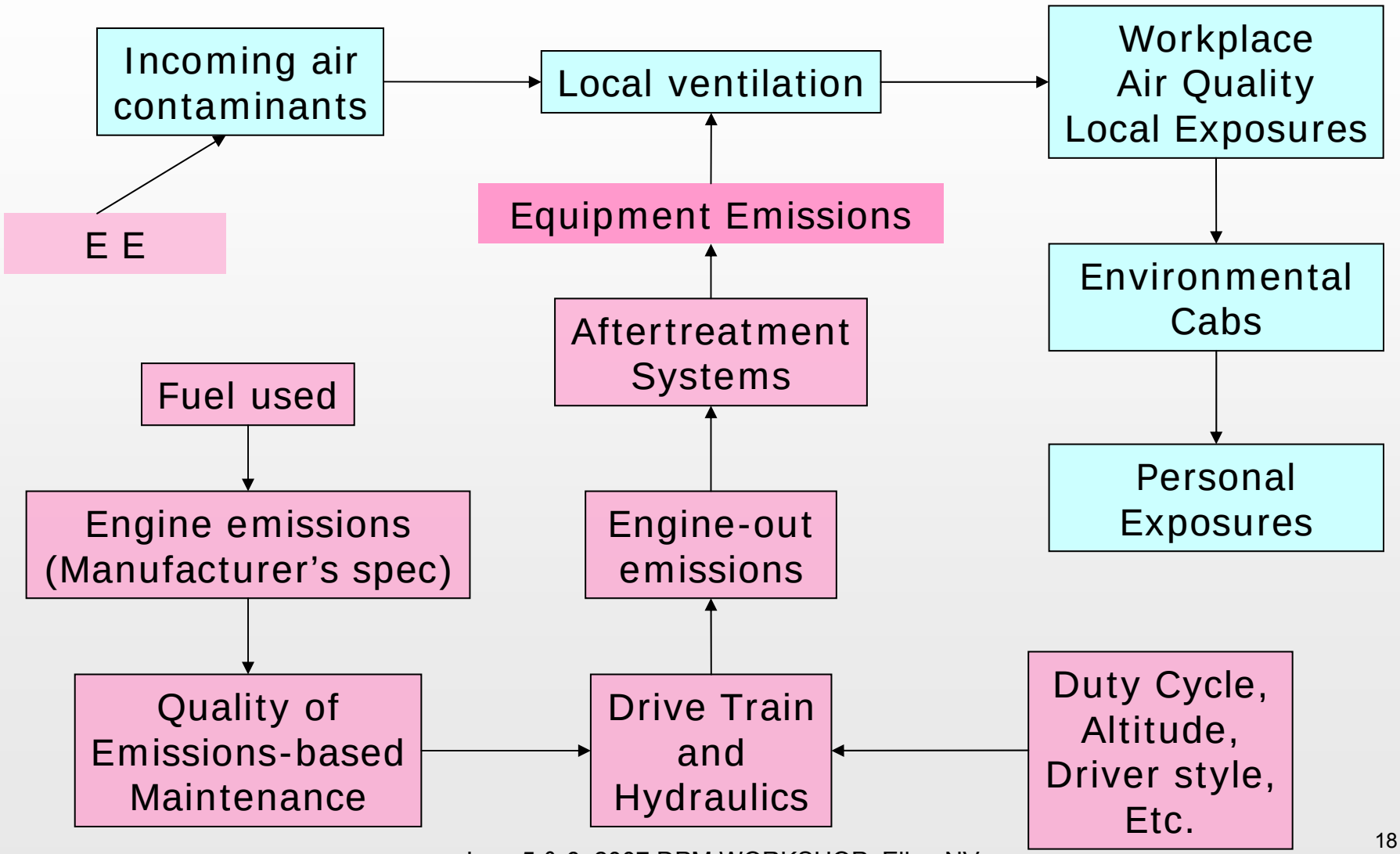


- Hint: Neither a malfunctioning engine (at the same power and rpm) nor addition of aftertreatment (DOC, DPF) change tailpipe CO_2 levels from that of a clean engine. Compare the DPM/CO_2 for “smoke belching” loader to a “smokeless” while mucking.

Using CO_2 measurements
applies to incoming and net workplace concentrations

CO_2 concentration	DPM/gas concentrations	Source of high concentration
High	High	Inadequate ventilation
Low	High	Engine/control malfunction
High	Low or moderate	Ventilation questionable
Low/moderate	Acceptable	Goal achieved!

Tailpipe emissions are the single source of workplace air contaminants and personal exposures.



Air contaminant quality control strategy

- Get and maintain control over the source of air contamination – tailpipe emissions
- Minimize the DPM, CO, NO and NO_2 emissions from the tailpipe (relative to the CO_2)
- Establish a QC QA program that guarantees that tailpipe emissions are within specifications *at all times.*

- Monitor workplace for CO_2 levels to ensure ventilation is adequate

Questions