Midwest Research Institute

Solutions through science and technology

Road Dust Control Performance Monitoring

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Emission Rate Calculation

$$R = M\ e\ (1 - c)$$

where:

- R = estimated emission rate (mass per time)
- M = source activity (veh-travel distance per time)
- e = uncontrolled emission factor (mass per veh-travel distance)
- c = fractional efficiency of control (re: untreated road)

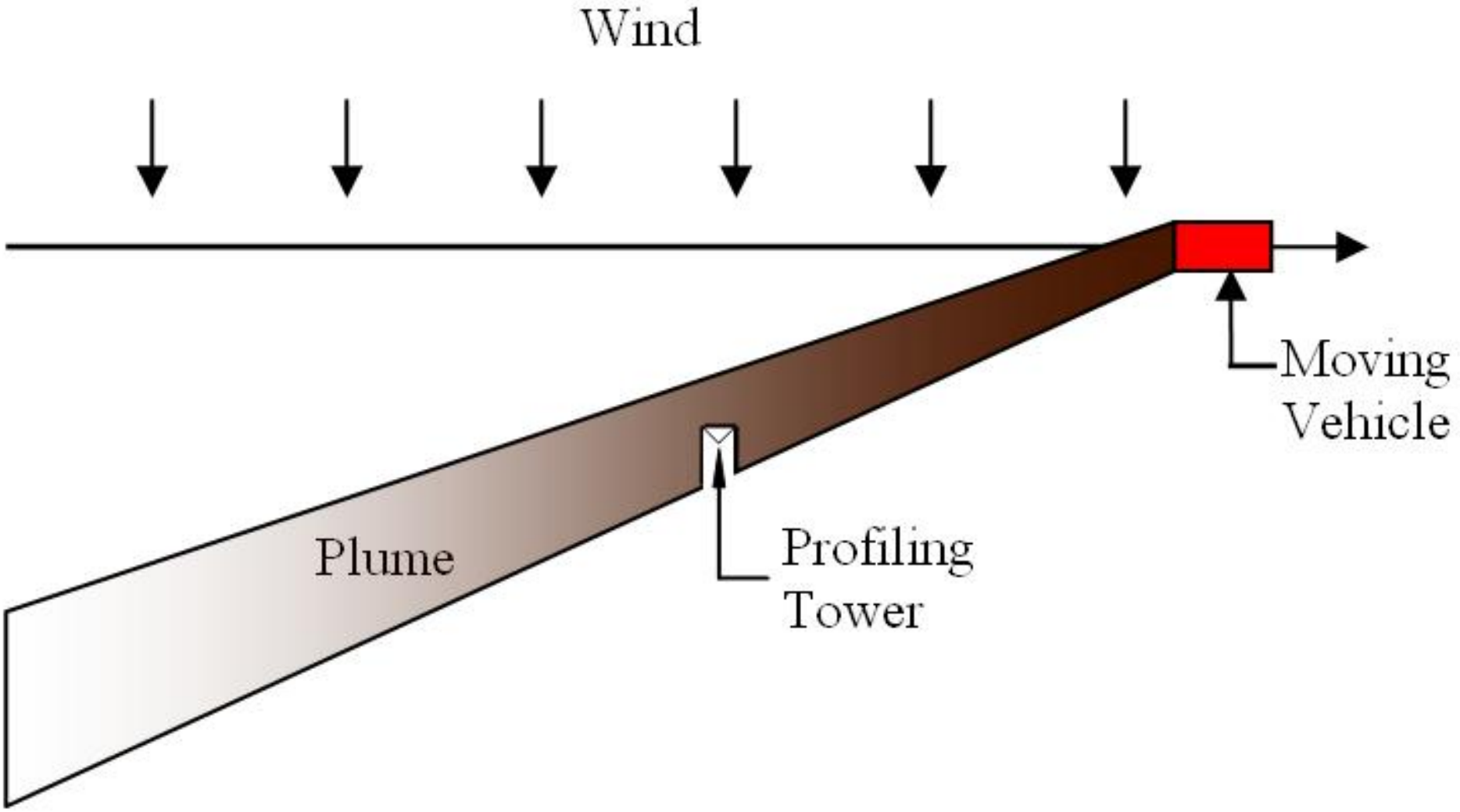
Emission Measurements

- Traditional Methods (crosswind conditions)
  - Plume Profiling
  - Reverse-Impact Dispersion Modeling
- New Methods (light winds preferred)
  - On-board Plume Sampling—Integrating (spatial averaging)
  - On-board Plume Sampling—Continuous (mapping)

Plume Profiling Reference Method

- Profiling Towers Deployed Immediately Downwind from Road Edge
- Multipoint Plume Measurements
  - Mass concentration
  - Particle size distribution
  - Wind speed
- Utilizes Mass Balance Calculation Scheme

Cross-Wind Dust Plume Dynamics



Reverse-Impact Modeling

- "Ground Level" Measurements (usually at approx. 2 m height)
  - Mass concentration
  - Particle size distribution
- Wind Speed (reference height for dispersion)
- Samplers Deployed in ambient impact zone: (>50 m downwind)
- Utilizes Dispersion Model Applied in Reverse

Onboard Sampling of Vehicle Plume

- Plume Concentration Measurement on Test Vehicle (e.g., wheel well, rear of vehicle)
- Time Integrating or Continuous Monitoring
- Vehicle Travels at Constant Speed
- “Transfer Standard” Calibrated Against Reference Method
- Calibration Will Vary with Vehicle Type/Speed

MRI Time Integrating Mobile Monitor for Testing of Dust Controls

Coarse Particle Cyclone Pre-collector
with PM-10 Back-up Filter (40 cfm)

On-Board Integrating Plume Sampler
(Developed for ETV Program)

Rear view showing alignment with truck

Air intake speed matches truck travel speed

High-volume cyclone

PM-2.5 cyclone

Close-up view of components

Control Performance Testing

- Control Application Parameters
  - Application intensity
  - Product dilution ratio
  - Application frequency
- Traffic Parameters
  - Average vehicle speed
  - Average vehicle weight
  - Traffic density (moderate = 50 to 200 vpd)

Control Performance Testing

- Must Represent Full Application Cycle(s)
  - Cycle must terminate when road surface is maintained (for surface binders)
- Must Account for Variations in Uncontrolled Emissions
  - Precipitation (rain and snow)
  - Night-time condensation
  - Effects of freeze-thaw cycles

Environmental Technology Verification (ETV)

- EPA Program for Independent Field and Laboratory Evaluations
- Dust Control Performance—Confidence Intervals
  - Control Efficiency (vs. Particle Size)
  - Maintenance Requirements
- Environmental Impacts—EPA Lab Tests
  - Waterways and soils
  - Plant and animal life
- Geographic Representation (Test Sites)

ETV Road Dust Control Evaluation

- Extensive Test Plan Development with Full Method Specification
- Selection of Dedicated Test Sites
  - 150 m treated sections
  - No grades, sharp curves or stop/go traffic
  - 16 m well-controlled buffer strips
  - 150 m untreated section as reference
- EPA Methods for Testing of Environmental Impacts

Road Sections for Long-Term Testing of Dust Controls (Ft. Leonard Wood)

Comparison of Mobile Sampling and Profiling Test Results

Size range	Line of best fit	R^2
PM-10	$y = 0.0268 x^{1.10}$	0.810
TP	$y = 0.129 x^{0.910}$	0.794
PM-2.5	$y = 0.0282 x^{0.697}$	0.905

"y" represents the emission factor in lb/vmt,
"x" denotes the mobile sampler test result in mg/1000 ft.

Roadside Removal of Airborne Particles—A New Finding

- Agglomeration and Deposition Phenomena
  - Dust particles are highly charged
  - Electrostatic agglomeration grows particles to sizes larger than 10 microns
  - Electrophoresis enhances deposition on groundcover
- Not Accommodated by Current Regulatory Dispersion Models

Sampler Comparisons under High-Dust Conditions

Field vs. Laboratory Testing

- **Field test environments** present difficult but real challenge conditions for control performance
- **Laboratory test environments** best for screening the characteristics of suppressants (e.g. leaching of toxic constituents) not related to emission control performance
- ETV strikes an appropriate **balance** as an exemplary program

Conclusions

- Standardized Evaluation Protocol (per ETV) with Defined QA and Statistical Measures
- Standardized Test Method—Field (On-Board) Monitor
- Representative Field Test Sites
  - Southeast Missouri (Ft. Leonard Wood)
  - Maricopa County (public road near Phoenix)
- Full Control Cycle Characterization (1 year)
- Test reports are available on the Internet http://www.epa.gov/etv/pubs