



12th VERT Forum

March 24, 2024

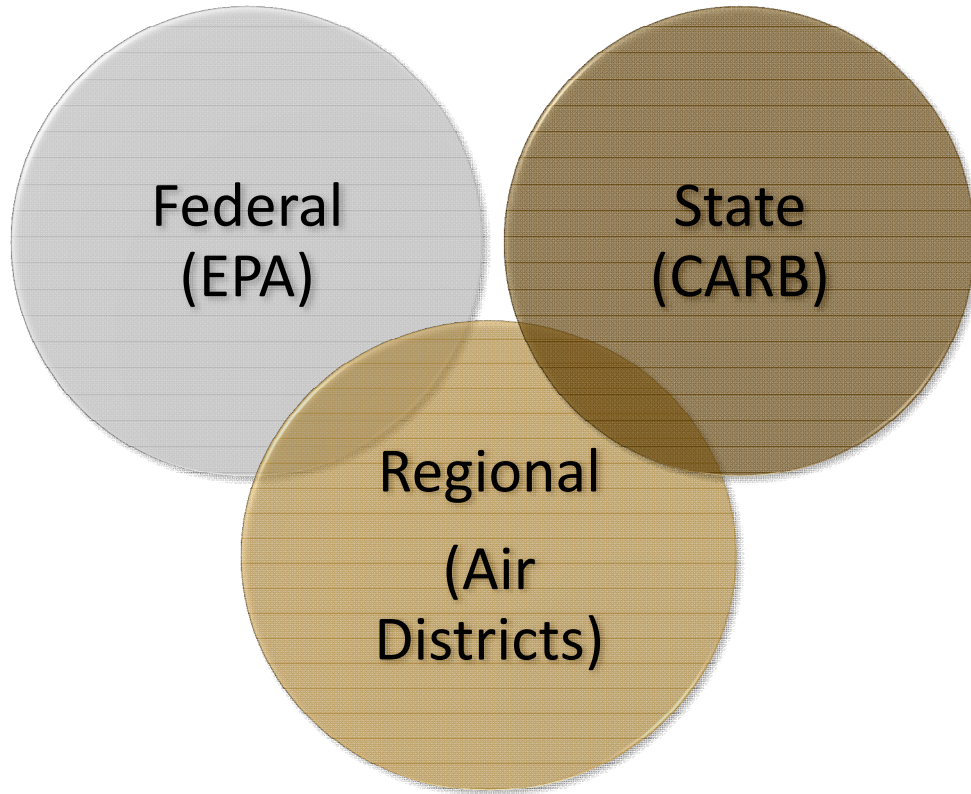
Why different approaches in the EU and the US? *Particle Pollution and US Air Quality Policy*

Dr. Alberto Ayala, PhD, MSE

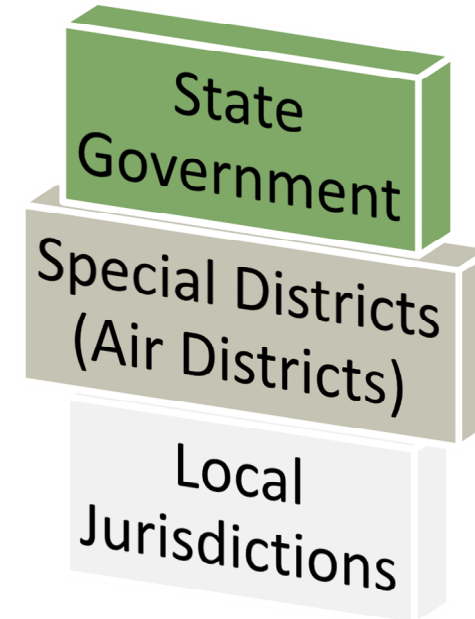
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(former) Deputy Executive Officer, California Air Resources Board



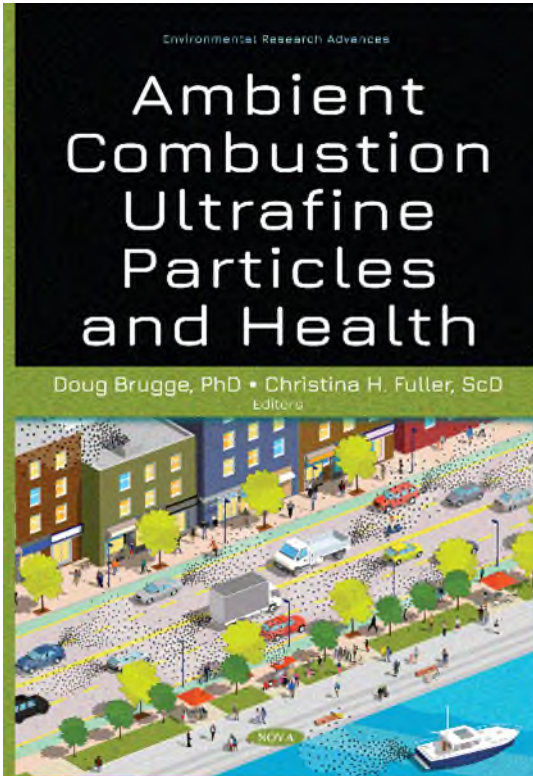
A word about government air agencies in the US



Shared responsibility and authority



Three levels of governance



**ULTRAFINE PARTICLES
AND AIR POLLUTION POLICY**

*Alberto Ayala, PhD, MSE**
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Sacramento Metropolitan Air Quality Management District;
Professor, Mechanical and Aerospace Engineering, West Virginia University;
(f) Deputy Executive Officer, California Air Resources Board

PREFACE

and an Inch Deep

discussing the policy landscape in the U.S. related to ultrafine particles (UFP), actions taken by environmental authorities to deal with this problem. After covering some background information, we will use the subject of internal combustion engine emissions of particulate matter (PM) to introduce the policy actions in the U.S. related to UFP. The story will lead us down the path of regulatory standards, other policy instruments, and research spanning the last three decades and conclude with a brief discussion of UFP in ambient air, traffic-related UFP emissions, and near-road air quality.

Any treatment of public policy for environmental protection necessarily will be broad and touch on many interrelated subjects that, threaded together, begin to form the basis for articulation of regulatory and other requirements. Many of those subjects can be highly technical and scientific in nature, requiring specific expertise to be able to draw policy-relevant conclusions. A policy discussion on air pollution and UFP is no exception. While in this chapter we will deal with a broad array of specialized topics such as air pollution, health effects, particle theory, measurements, experimentation, instrumentation, internal combustion, technology, public process, and government bureaucracy, we can do it only superficially. The reader is forewarned to be ready and is highly encouraged, especially if she is a current student, to conduct additional reading and research on these subjects. We will explore the policy landscape in the U.S. and Europe related to UFP pollution and discover that while there may be a lack of

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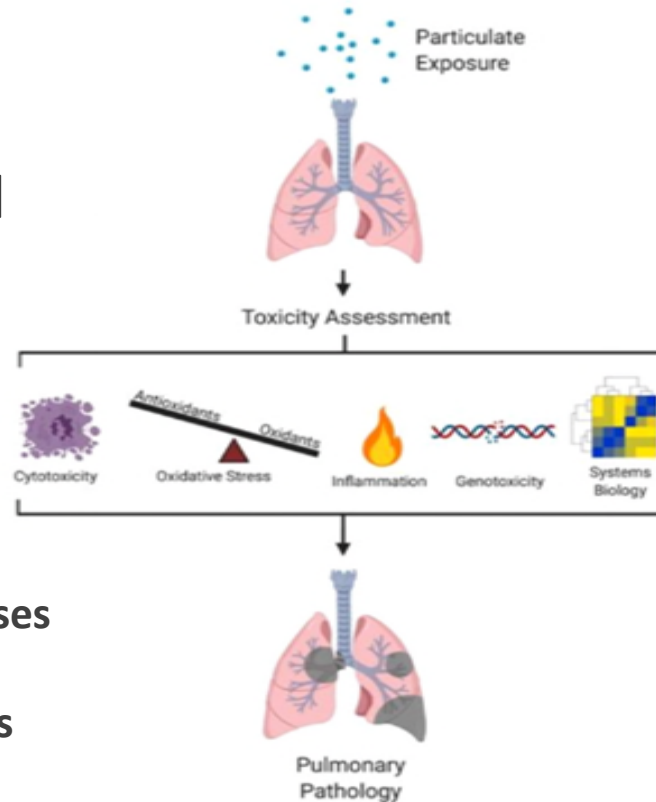


Today, we are at a classic glass half-full or half-empty stage. The evidence for concern [about ultrafine particle pollution] has grown substantially, but falls short of being convincing to regulators for enacting general policies, especially at the national level

Quantification of Health Benefits of California's Air Quality Regulations, Plans, and Programs

Traditional approach:

- Small subset of morbidity and mortality outcomes
 - premature cardiopulmonary mortality
 - hospital admissions for cardiovascular illness
 - hospital admissions for respiratory illnesses
 - emergency room visits for asthma attacks

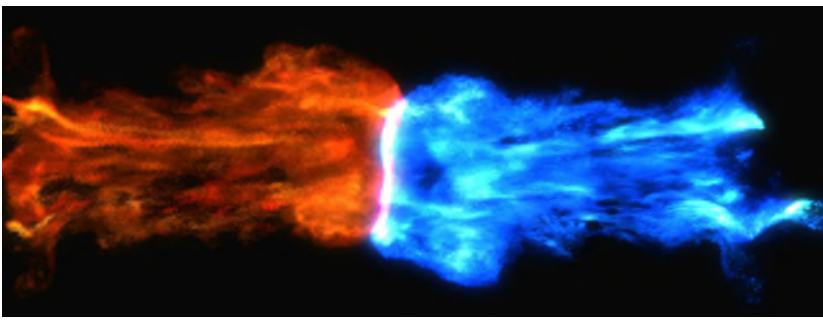


Updated:


- New set of morbidity and mortality outcomes
 - hospitalizations
 - emergency room visits
 - missed work and school days
 - other burdens

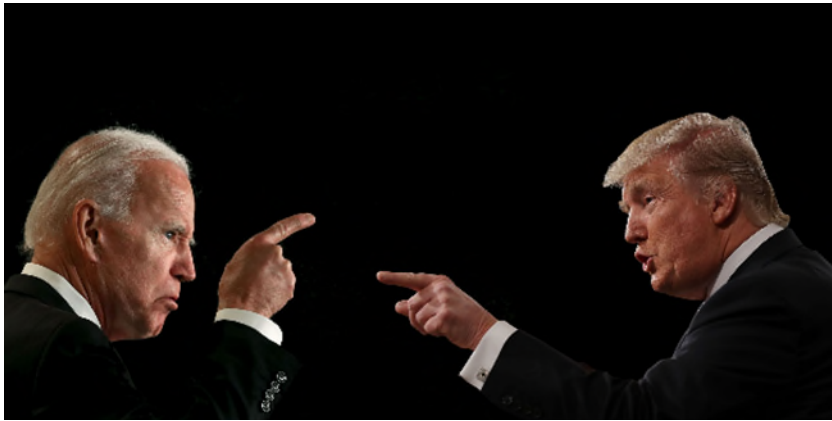
Figure 2. Exposure pathway and potential outcomes of inhaled combustion derived particulate matter.

Do ultrafine particles fit in?

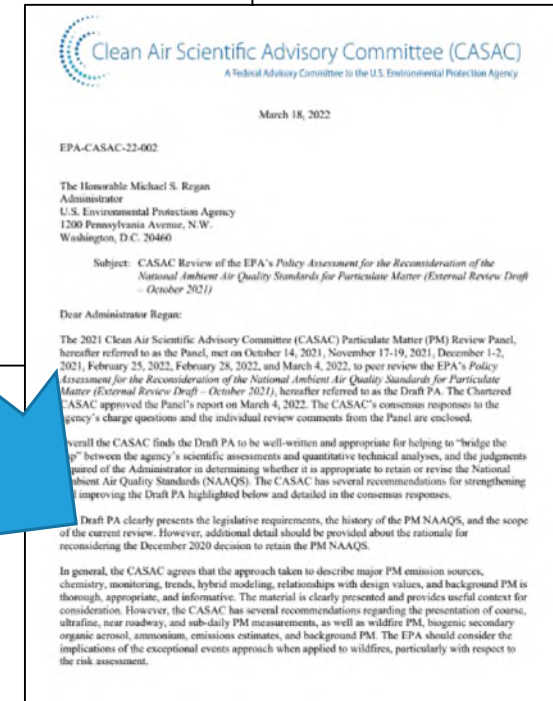
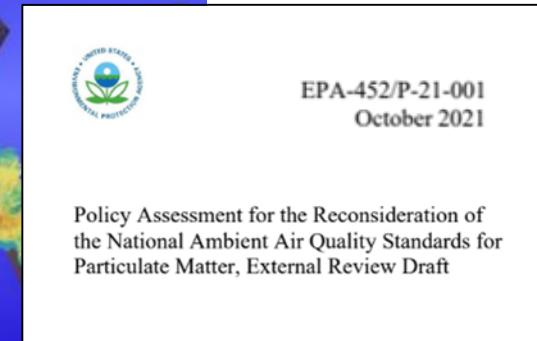
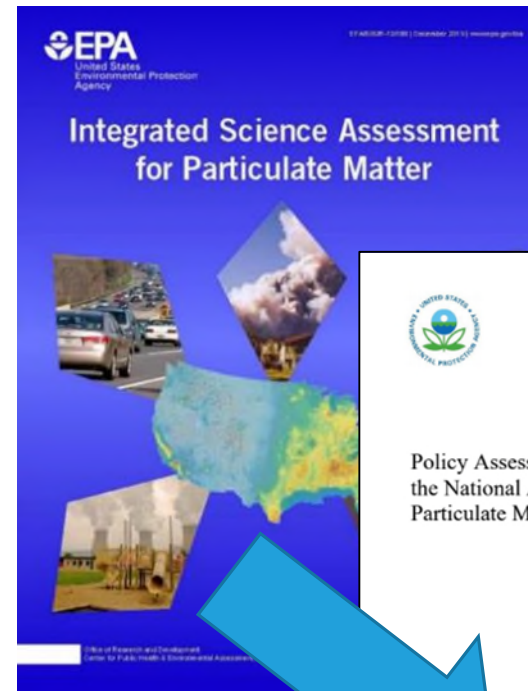


Policy Forcers at Play

- Ozone and PM pollution reductions still sorely needed in the US
- National Ambient Air Quality Standards (NAAQS) for Ozone and PM are top priorities (no explicit emphasis on ultrafine particles....yet)
- California heavily focused on decarbonization and electrification, less so
 - Not paying enough attention to conventional pollution
- New federal review of O₃ and PM NAAQS underway (how will ultrafine particles be treated?)
- Research continues (modelling, exposure assessment, and micro-environments)
-  \$12 million NSF grant for nationwide atmospheric measurement network including aerosol particle size (TSI SMPS)
- Prof. Sally Ng and 12+ partners deploying 12 sites



- 2019 - Trump EPA: evidence still inadequate or insufficient to determine causality of morbidity or mortality outcomes and exposure to ultrafine particle pollution
- 2021 - Biden EPA: PM standards review underway
- 2022 – Biden EPA: may disagree because...
- March 18, 2022 CASAC recommends lower PM2.5 standards
- “sticking with PM2.5 mass definitions”



Is there a brewing inconsistency in federal policy?



- EPA proposed aircraft PM standards
- Dec 2021 - adoption of ICAO standards
- Visibility (mass concentration)
- Mass
- Number
- Effective date Jan 1, 2021



The Knowns

- Animal toxicological evidence linking long-term ultrafine particle exposure to nervous system effects
- Translocation of ultrafine particles outside respiratory tract to circulatory and brain systems via olfactory nerve and other pathways
- Observed neurological effects attributable to ultrafine particle pollution exposure

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Air Pollution, Ultrafine Particles, and Your Brain: Are Combustion Nanoparticle Emissions and Engineered Nanoparticles Causing Preventable Fatal Neurodegenerative Diseases and Common Neuropsychiatric Outcomes?

Lilian Calderón-Garcidueñas and Alberto Ayala*

Cite This: <https://doi.org/10.1021/acs.est.1c04706>

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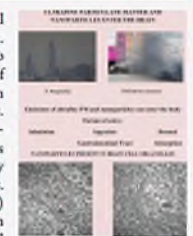
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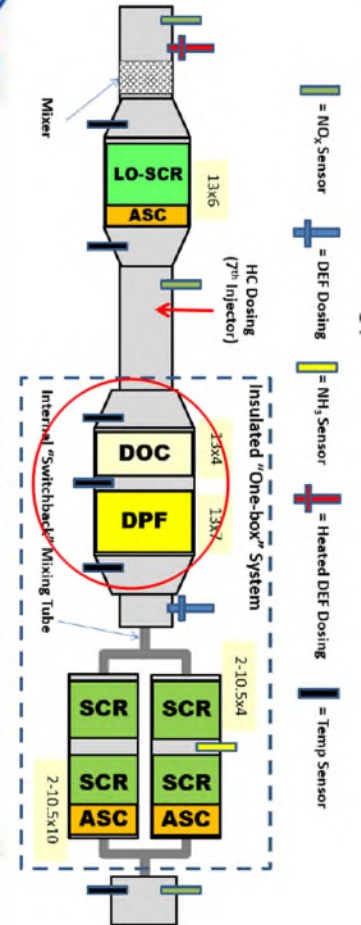



Article Recommendations

ABSTRACT: Exposure to particulate matter (PM) pollution damages the human brain. Fossil fuel burning for transportation energy accounts for a significant fraction of urban air and climate pollution. While current United States (US) standards limit PM ambient concentrations and emissions, they do not regulate explicitly ultrafine particles (UFP ≤ 100 nm in diameter). There is a growing body of evidence suggesting UFP may play a bigger role inflicting adverse health impacts than has been recognized, and in this perspective, we highlight effects on the brain, particularly of young individuals. UFP penetrate the body through nasal/olfactory, respiratory, gastrointestinal, placenta, and brain–blood barriers, translocating in the bloodstream and reaching the glymphatic and central nervous systems. We discuss one case study. The 21.8 million residents in the Metropolitan Mexico City (MMC) are regularly exposed to fine PM ($PM_{2.5}$) above the US $12 \mu\text{g}/\text{m}^3$ annual average standards. Alzheimer’s disease (AD), Parkinson’s disease (PD), and TAR DNA-binding protein (TDP-43) pathologies and nanoparticles (NP ≤ 50 nm in diameter) in critical brain organelles have been documented in MMC children and young adult autopsies. MMC young residents have cognitive and olfaction deficits, altered gait and equilibrium, brainstem auditory evoked potentials, and sleep disorders. Higher risk of AD and vascular dementia associated with residency close to high traffic roadways have been documented. The US is not ready or prepared to adopt ambient air quality or emission standards for UFP and will continue to focus regulations only on the total mass of $PM_{2.5}$ and PM_{10} . Thus, this approach raises the question: *are we dropping the ball?* As research continues to answer the remaining questions about UFP sources, exposures, impacts, and controls, the precautionary principle should call us to accelerate and expand policy interventions to abate or eliminate UFP emissions and to mitigate UFP exposures. For residents of highly polluted cities, particularly in the developing world where there is likely older and dirtier vehicles, equipment, and fuels in use and less regulatory oversight, we should embark in a strong campaign to raise public awareness of the associations between high PM pollution, heavy traffic, UFP, NP, and neuropsychiatric outcomes, including dementia. Neurodegenerative diseases evolving from childhood in polluted, anthropogenic, and industrial environments ought to be preventable.

KEYWORDS: Air pollution, brain, vehicular emissions, nanoparticles, ultrafine particles, dementia, neurodegeneration, Metropolitan Mexico City



“Check the box” on PM and NO_x and super-low NO_x-emission control thanks to high-efficiency post-combustion devices*

PM and NO _x Emissions	DOC + DPF +SCR + Better Systems Coming	Oxidation, Filtration, and Reductions	99.9% reductions in PM emissions possible	PM Control from ICEs
				

**as long as they work as intended in the real world- throughout useful life and there's no more cheating....*

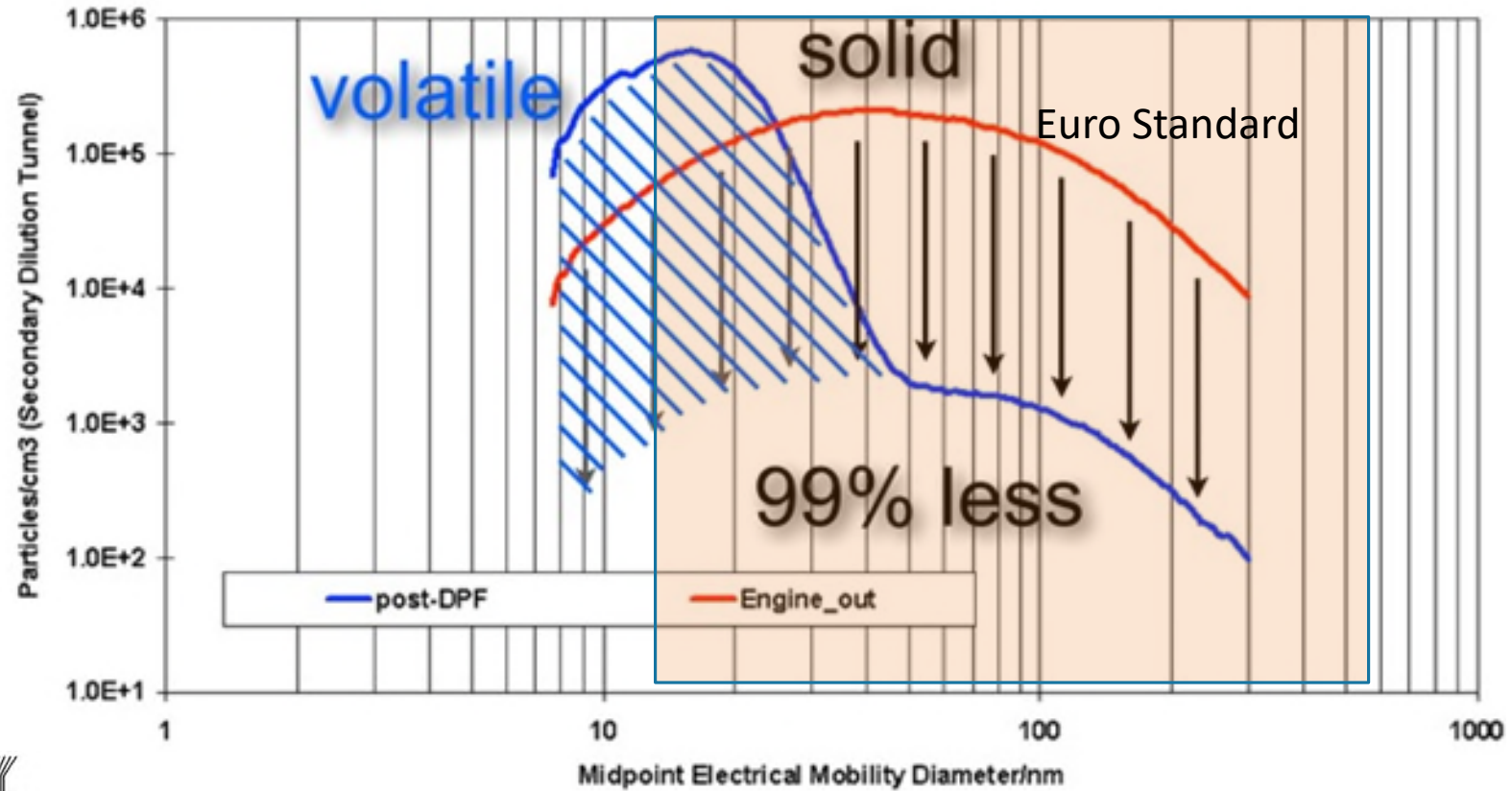
Legislative direction* for new heavy-duty vehicle I/M program

- January 1, 2023
- Remote OBD and opacity for non-OBD trucks
- Roadside monitoring
- Targeting malfunctioning trucks
- Portable Emissions Acquisition System (PEAQS) – CO2, NOx, BC
- Not PNPTI



*Senate Bill 210 (Leyva; Chapter 298, Statutes of 2019)

Where we left off



Aerosol Science and Technology, 43:962–969, 2009
Copyright © American Association for Aerosol Research
ISSN: 0278-6829 print / 1521-7388 online
DOI: 10.1080/02786820903074810



Evaluation of the European PMP Methodologies during On-Road and Chassis Dynamometer Testing for DPF Equipped Heavy-Duty Diesel Vehicles

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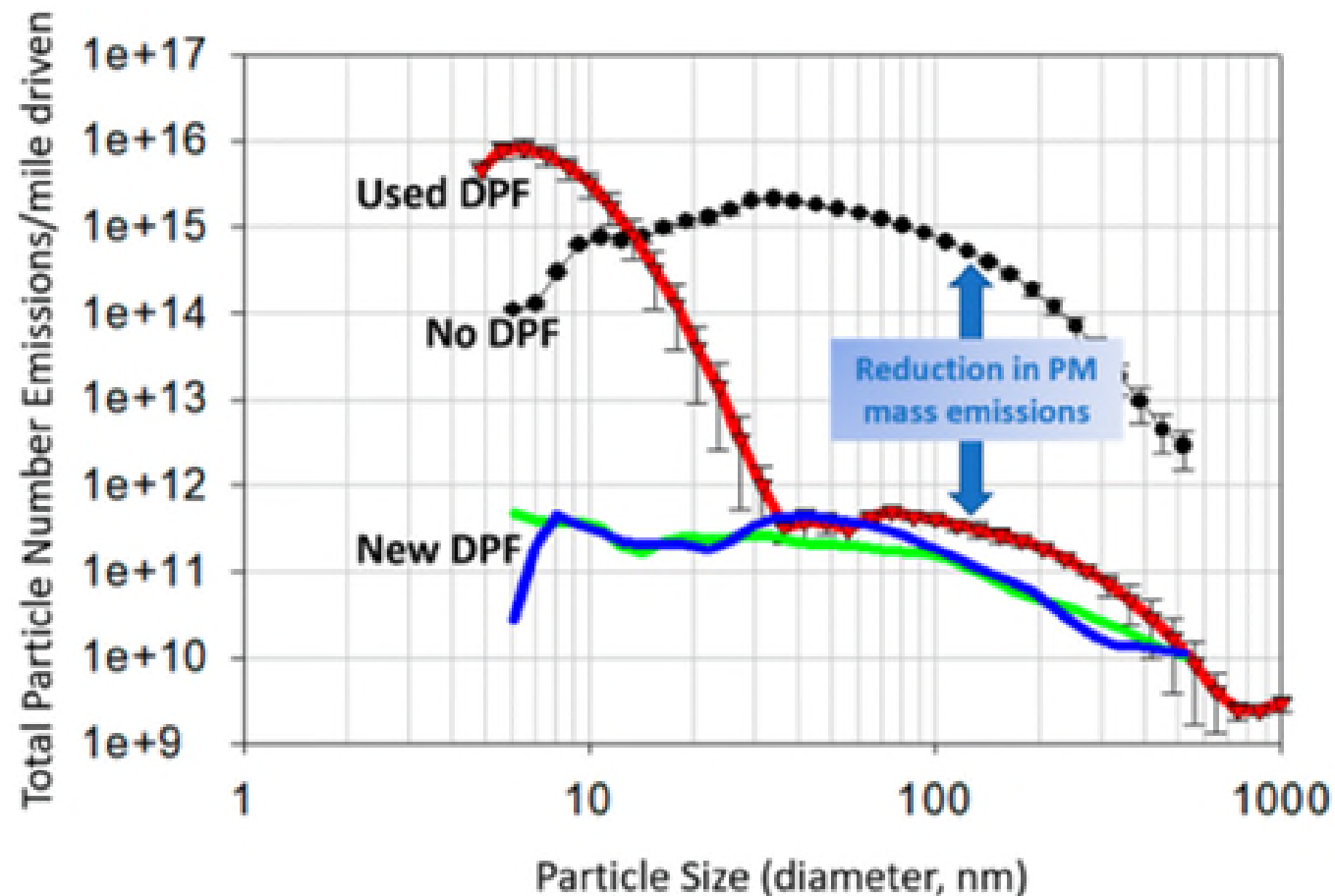


Figure 2. DPF storage and release mechanism illustrated by UFP particle emissions (total number of particles/mile) from various diesel vehicles equipped with different aftertreatment controls. Circles are a

Euro 7/VII Developments



- “safeguard measures against non-compliant vehicles”
- Euro Commission with teeth: “compliance and conformity checks in laboratories or on the road” [looking for defeat devices and] “Commission can order recalls and impose sanctions”
- RDE and ultrafine particle monitoring and control?

Final Remarks and Thank you!



Today, we are at a classic glass half-full or half-empty stage. The evidence for concern [about ultrafine particle pollution] has grown substantially, but falls short of being convincing to regulators for enacting general policies, especially at the national level