

# Science Policy Outreach Task Force at Northwestern University

## Diesel exhaust particulates: Effects on the body & identifying susceptible populations



*SPOTlight: Diesel exhaust particulates have lasting, negative effects on the body and disproportionately affect urban POC populations near the Illinois Port District.*

### What is diesel exhaust?

- Diesel exhaust is one of the most prevalent human-generated pollutants worldwide, spurred by the dominance of diesel engines in economic sectors such as the Iroquois Landing Terminal and Calumet Lake Terminal [1].
- Diesel exhaust consists of solid and liquid particulates and gaseous components [1] and is listed as a Group 1 carcinogen by the International Agency for Research on Cancer (IARC) [2].
- Diesel exhaust particulates (DEPs) exist in a range of sizes, divided into several categorizations: PM<sub>10</sub> (particulates with diameter less than 10 μm), PM<sub>2.5</sub> (diameter less than 2.5 μm), ultrafine particles (diameters below 0.1 μm), and nanoparticles (diameters less than 50 nm) [3,4,5].
- Elemental carbon is the most common component of solid particulates, with various metals and metal oxides also present (i.e., Ce, Fe, Mn, Pt, Cu). In addition to solids, gaseous components are predominantly non-toxic inorganics (N<sub>2</sub>, H<sub>2</sub>O, O<sub>2</sub>), with the remainder being toxic inorganic gases (NO, NO<sub>2</sub>, CO<sub>2</sub>, CO) and a mixture of organic compounds [1].

### Can the respiratory tract defend against DEPs?

- There are natural filtration and particle clearance mechanisms in the respiratory tract targeted at larger solid particulates, but smaller particulates often travel deeper into the respiratory tract, while gaseous compounds are wholly unaffected by these filters [1].
- The timescale of filtration varies between respiratory tract regimes - removal from the body happens within minutes in the outermost region, while in the innermost region it ranges between weeks to months [1].

### How do diesel exhaust particulates affect the human body?

- The varied composition of DEPs lead to complex interactions with the pulmonary system, thus, establishing concrete links between specific components and bodily responses is ongoing work [1,6].
- Studies do show that DEPs are found to induce *pulmonary oxidative stress*, which has been strongly associated with asthma, lung cancer, and chronic obstructive pulmonary disease (COPD) [1,6,7].
- Pulmonary oxidative stress is a shift away from the resting antioxidant capacity in the lungs, which results in imbalances in normal bodily functions [1,6,7,8].
- DEPs can also affect the brain via inflammation of the cerebral vascular system and damage to cranial nerves, resulting in a number of diseases, including but not limited to: stroke, Alzheimer's, Parkinson's, cognitive impairment, and depression [9].

### Which populations are most susceptible to DEPs?

- Due to underdeveloped alveolar regions and juvenile immune systems, children are more susceptible than adults to adverse effects from DEP exposure, such as stunted lung development [6,10,11].
- The elderly (greater than 65 years of age) and those with preexisting cardiovascular and respiratory diseases are commonly agreed to be susceptible populations [12].
- Studies show that persons of color (POCs) are disproportionately exposed to DEPs and other PM<sub>2.5</sub> pollutants, especially compared to white populations. This disproportionate exposure is more pronounced in urban settings and is not strongly affected by differences in income across POC populations [13,14].
- Populations living in redlined neighborhoods (those with the lowest grade in the Home Owners' Loan Corporation's racially discriminatory federal mortgage appraisal policy, lasting from 1930s to 1968) are exposed to higher concentrations of NO<sub>2</sub> and PM<sub>2.5</sub> relative to a city's average concentrations [15]. This is evident in communities around the Calumet Lake Terminal [16,17].

### What are existing exposure limitations for diesel exhaust pollutants?

- The current health-based National Ambient Air Quality Standard (NAAQS) for Particulate Matter (specifically PM<sub>2.5</sub>) is set at a maximum of 9.0 μg/m<sup>3</sup> [18].
  - The World Health Organization 2021 Global Air Quality Guidelines (WHO AQG) recommends not to exceed yearly average PM<sub>2.5</sub> concentrations of 5 μg/m<sup>3</sup> and NO<sub>2</sub> concentrations of 10 μg/m<sup>3</sup> [19].
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