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Lung Deposition of Jet Engine Exhaust Particulate Matter

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ABSTRACT
Particulate matter (PM) from on-road vehicular traffic has been correlated to increases in mortality and morbidity as PM concentrations increase. Like vehicular exhaust PM, jet engine exhaust (JEE) PM falls within the size range of interest when considering health effects. Despite this, no information currently exists on the inhalation health impact of JEE PM. JEE PM has unique properties with respect to deposition, retention kinetics, and clearance pathways in the human respiratory system, and is composed of sizes that readily travel gas streamlines that penetrate the deepest regions of the lung; this is a concern as deposited JEE PM in these regions could potentially cross the blood-membrane barrier and migrate into the bloodstream. Using JEE PM data collected during plume studies performed down-wind of active runways at the Hartsfield-Jackson Atlanta and Oakland International Airports, lung deposition probabilities of JEE PM (as a function of particle size) can be determined using the International Committee of Radiological Protection (ICRP) lung deposition model. Surface area, however, is the characteristic PM parameter most strongly correlated with health impacts. Using the deposition probabilities and size resolved number distributions, a Surface Area Deposition Index (SADI) was developed. This new parameter, SADI, quantizes JEE PM lung deposition as the surface area of deposited PM per kilogram fuel burned. As constructed, SADI allows for equitable comparison among jet engine types while also proving a surface area metric for meaningful health impact correlations. Two interesting conclusions to this preliminary study are that statistically significant differences among engine types are not seen in SADI, and variations in SADI are not correlated with temporal changes or changes in meteorological conditions.