

carbon level, one must first estimate the percentage of PM attributable to diesel engines and the percentage of elemental carbon in diesel PM. Thus, there are significant uncertainties in estimating diesel PM concentrations using an elemental carbon surrogate. Depending on the measurement technique used, and assumptions made, average nationwide concentrations for current years of diesel PM estimated from elemental carbon data range from about 1.2 to 2.2 $\mu\text{g}/\text{m}^3$. EPA has compared these estimates based on elemental carbon measurements to modeled concentrations in NATA and concluded that the two sets of data agree reasonably well. This performance compares favorably with the model to monitor results for other pollutants assessed in NATA, with the exception of benzene, for which the performance of the NATA modeling was better. These comparisons are discussed in greater detail in the draft RIA.

(3) Chemical Mass Balance

The third approach for estimating ambient diesel PM concentrations uses the CMB model for source apportionment in conjunction with ambient PM measurements and chemical source "fingerprints" to estimate ambient diesel PM concentrations. The CMB model uses a statistical fitting technique to determine how much mass from each source would be required to reproduce the chemical fingerprint of each speciated ambient monitor. This source apportionment technique presently does not distinguish between on-road and nonroad but, instead, gives diesel PM as a whole. This source apportionment technique can distinguish between diesel and gasoline PM. Caution in interpreting CMB results is warranted, as the use of fitting species that are not specific to the sources modeled can lead to misestimation of source contributions. Ambient concentrations using this approach are generally about 1 $\mu\text{g}/\text{m}^3$ annual average. UNMIX/PMF models show similar results. Results from various studies are discussed in the draft RIA.

iv. Diesel Exhaust PM Exposures

Exposure of people to diesel exhaust depends on their various activities, the time spent in those activities, the locations where these activities occur, and the levels of diesel exhaust pollutants (such as particulate) in those locations. The major difference between ambient levels of diesel particulate and exposure levels for diesel particulate is that exposure accounts for a person moving from location to location,

proximity to the emission source, and whether the exposure occurs in an enclosed environment.

(1) Occupational Exposures

Diesel particulate exposures have been measured for a number of occupational groups over various years but generally for more recent years (1980s and later) rather than earlier years. Occupational exposures had a wide range varying from 2 to 1,280 $\mu\text{g}/\text{m}^3$ for a variety of occupational groups including miners, railroad workers, firefighters, air port crew, public transit workers, truck mechanics, utility linemen, utility winch truck operators, fork lift operators, construction workers, truck dock workers, short-haul truck drivers, and long-haul truck drivers. These individual studies are discussed in the Diesel HAD. As discussed in the Diesel HAD, the National Institute of Occupational Safety and Health (NIOSH) has estimated a total of 1,400,000 workers are occupationally exposed to diesel exhaust from on-road and nonroad equipment.

Many measured or estimated occupational exposures are for on-road diesel engines although some (especially the higher ones) are for occupational groups (*e.g.*, fork lift operators, construction workers, or mine workers) who would be exposed to nonroad diesel exhaust. Sometimes, as is the case for the nonroad engines, there are only estimates of exposure based on the length of employment or similar factors rather than a $\mu\text{g}/\text{m}^3$ level. Estimates for exposures to diesel PM for diesel fork lift operators have been made that range from 7 to 403 $\mu\text{g}/\text{m}^3$ as reported in the Diesel HAD. In addition, the Northeast States for Coordinated Air Use Management (NESCAUM) is presently measuring occupational exposures to particulate and elemental carbon near the operation of various diesel non-road equipment. Exposure groups include agricultural farm operators, grounds maintenance personnel (lawn and garden equipment), heavy equipment operators conducting multiple job tasks at a construction site, and a saw mill crew at a lumber yard. Samples will be obtained in the breathing zone of workers. Some initial results are expected in late 2003.

(2) General Ambient Exposures

Currently, personal exposure monitors for PM cannot differentiate diesel from other PM. Thus, we use modeling to estimate exposures. Specifically, exposures for the general population are estimated by first conducting dispersion modeling of both on-road and non-road diesel emissions,

described above, and then by conducting exposure modeling. The most comprehensive modeling for cumulative exposures to diesel PM is the NATA. This assessment calculates exposures of the national population as a whole to a variety of air toxics, including diesel PM. As discussed previously, the ambient levels are calculated using the ASPEN dispersion model. The preponderance of modeled diesel PM concentrations are within a factor of 2 of diesel PM concentrations estimated from elemental carbon measurements.³⁸ This comparison adds credence to the modeled ASPEN results and associated exposure assessment.

The modeled ambient concentrations are used as inputs into the Hazardous Air Pollution Exposure Model (HAPEM4) to calculate exposure levels. Average exposures calculated nationwide are 1.44 $\mu\text{g}/\text{m}^3$ with levels of 1.64 $\mu\text{g}/\text{m}^3$ for urban counties and 0.55 $\mu\text{g}/\text{m}^3$ for rural counties. Again, nonroad diesels account for over half of this modeled exposure.

(3) Ambient Exposures—Microenvironments

One common microenvironment for diesel exposure is beside freeways. Although freeway locations are associated mostly with on-road rather than nonroad diesels, there are many similarities between on-road and nonroad diesel emissions as discussed in the Diesel HAD. The California Air Resources Board (CARB) measured elemental carbon near the Long Beach Freeway in 1993. Levels measured ranged from 0.4 to 4.0 $\mu\text{g}/\text{m}^3$ (with one value as high as 7.5 $\mu\text{g}/\text{m}^3$) above background levels. Microenvironments associated with nonroad engines would include construction zones. PM and elemental carbon samples are being collected by NESCAUM in the immediate area of the nonroad engine operations (such as at the edge or fence line of the construction zone). Besides PM and elemental carbon levels, various toxics such as benzene, 1,3-butadiene, formaldehyde, and acetaldehyde will be sampled. Some initial results should be available in late 2003 and will be especially useful since they focus on those microenvironments affected by nonroad diesels.

Also, EPA is funding research in Fresno to measure indoor and outdoor PM component concentrations in the homes of over 100 asthmatic children. Some of these homes are located near

³⁸ U.S. EPA (2002). Diesel PM model-to-measurement comparison. Prepared by ICF Consulting for EPA, Office of Transportation and Air Quality. Report No. EPA420-D-02-004.