

four general categories for calculating summary statistics: metal, stone, trona, and other nonmetal (N/M) mines. These categories were selected to be consistent with the categories used for analysis of data for the 31-Mine Study. Most commodities are well represented in this analysis (average of 5.1 samples per mine). Some of these mines, such as the gold mines, have an average of only 2.0 samples per mine. MSHA is conducting additional compliance assistance sampling at these mines, however, the results are not available for inclusion in this analysis. Table V-2 lists the number

of samples for each category of commodity. MSHA used the same sampling strategies for collecting baseline samples as it intends to use for collecting samples for enforcement purposes. These sampling procedures are described in the *Metal and Nonmetal Health Inspection Procedures Handbook (PH90-IV-4)*, Chapter A, "Compliance Sampling Procedures" and Draft Chapter T, "Diesel Particulate Matter Sampling." Chapter A includes detailed guidelines for selecting and obtaining personal samples for various

contaminants. All personal samples were collected for the miner's full-shift regardless of the number of hours worked, and in the miner's breathing zone. For the 874 valid personal samples, 83% were collected for at least eight hours. Total and elemental carbon levels, as well as DPM levels, are reported in units of micrograms per cubic meter for an 8-hour full shift equivalent. The equation used to calculate a 480-minute (8-hour) full shift equivalent (FSE) exposure of total carbon is Total Carbon Concentration =

$$\frac{[EC \times 1.3] \text{ or } [OC + EC] \left(\mu\text{g} / \text{cm}^2 \right) \times A \left(\text{cm}^2 \right) \times 1,000 \left(\text{L} / \text{m}^3 \right)}{\text{Flow Rate (Lpm)} \times 480 \text{ (minutes)}}$$

Where:
EC = The corrected elemental carbon concentration measured in the thermal/optical carbon analyzer
OC = The corrected organic carbon concentration measured in the thermal/optical carbon analyzer
A = The surface area of the deposit on the filter media used to collect the sample
Flow Rate = Flow rate of the air pump used to collect the sample measured in Liters per minute
480 minutes = Standardized eight-hour workshift
All levels of carbon or DPM are reported in 8-hour full shift equivalent (FSE) total carbon concentrations measured in $\mu\text{g}/\text{m}^3$.
Because personal sampling was conducted and no attempt was made to avoid interference from cigarette smoke or other organic carbon sources, total carbon was also calculated using the formula prescribed in the DPM settlement agreement:
Total Carbon Concentration = $EC \times 1.3$.
MSHA agreed to use the lower of the two values ($EC \times 1.3$ or $EC + OC$) for enforcement until a final rule is published reflecting EC as the surrogate.
MSHA collected DPM samples with SKC submicron dust samplers that use

Dorr-Oliver cyclones and submicron impactors. The samples were analyzed either at MSHA's Pittsburgh Safety and Health Technology Center, Dust Division Laboratory or at the Clayton Laboratory using MSHA Method P-13 (NIOSH Analytical Method 5040, *NIOSH Manual of Analytical Methods (NMAM)*, Fourth Edition, September 30, 1999) for determining the total carbon content. Each sample was analyzed for organic, elemental, and carbonaceous carbon and calculated total carbon. Raw analytical results from both laboratories as well as administrative information about the sample are stored electronically in MSHA's Laboratory Information Management System.
If a raw carbon result was greater than or equal to $30 \mu\text{g}/\text{cm}^2$ of EC or $40 \mu\text{g}/\text{cm}^2$ of TC from the exposed filter loading, then the analysis was repeated using a separate punch of the same filter. The results of these two analyses were then averaged. The companion dynamic blank was also tested for the same analytes. Otherwise, an unexposed filter from the same manufacturer's lot was used to correct for background levels. In the event the initial total carbon result was greater than $100_{EC} \mu\text{g}/\text{cm}^2$, a smaller punch of the same exposed filter (in duplicate and corresponding blank) was taken and

used in the analysis. Blank-corrected averaged results were used in the analysis when the sample was tested in duplicate.
Generally the lowest reporting limit is $3_{TC} \mu\text{g}/\text{cm}^2$. However, for this analysis, MSHA used all results below this limit. Due to variations in the analytical method, three samples have blank corrected elemental carbon results slightly below $0_{EC} \mu\text{g}/\text{m}^3$. This occurred because the corresponding blank filters have TC results slightly more than the exposed filter. Median values are not affected by the distribution of data and MSHA included them where appropriate.
The electronic records of the 885 samples that were available for analysis were reviewed for inconsistencies. Internally inconsistent or extreme values were questioned, researched, and verified. Although no samples were invalidated as a result of the administrative verification, eleven samples (1.2%) were removed from the data set for reasons unrelated to the values obtained. The reasons for invalidating these samples are listed in Table V-1. Accordingly, MSHA has included 874 samples from miners in the analyses. Table V-2 is a list of the number of valid samples by commodity.

TABLE V-1.—REASONS FOR EXCLUDING SAMPLES

Reason for excluding from analysis	Metal	Stone	Trona	Other N/M	Total
Abnormal Sample Deposit	0	1	0	0	1
Cassette/Filter Broken	0	2	0	1	3
Contaminated Backup Pad	1	0	0	0	1
Instrument Failure	1	1	0	0	2
Pump Failed	1	3	0	0	4
Total	3	7	0	1	11