

obtained by ambient sampling to convert the respirable mass levels to total mass levels (using Chimera/TSI Disfit software). The reported levels represent these total mass values, and form the basis of the reported WPF values. The authors also provide data and discussion on a number of sampling analyses, including GM concentration of analyte by job task, GM concentration of analyte for in-mask and ambient concentrations, particle size distribution by job category, GM WPF estimates by job category, GM WPF by respirator type, within shift sampling variation, and variation between foundries. For the pooled data from the three foundries, the 3M 9920 filtering facepiece had a 50% WPF of 108, a GSD of 5.2, and a fifth percentile estimate of 7. The AO half-mask had a 50% WPF estimate of 98, a geometric standard deviation (GSD) of 5.8, and a fifth percentile WPF of 5. The MSA Comfo II half-mask had a 50% WPF of 163, a GSD of 3.1, and a fifth percentile WPF of 26. The Scott half-mask had a 50% WPF of 94, a GSD of 4.8, and a fifth percentile WPF of 7. For all respirators a 50% WPF of 114, a GSD of 4.6, and a fifth percentile estimate of 9 was reported. The authors concluded that “* * * dust-fume-mist (DFM) half-facepiece respirators, when conscientiously used, worn, and maintained, provided effective worker protection.”

Study 8. W.R. Meyers and Z. Zhuang in January, 1993 (Ex. 1–64–51) and W.R. Myers, Z. Zhuang, and T.J. Nelson in 1996 (Ex. 3–12) reported on the second part of the three-part study, which evaluated protection against exposure to particulate iron (Fe) for 16 workers in the sinter plant and basic oxygen process (BOP) facility of a steel manufacturing plant. In addition, exposure to particulate calcium (Ca) in the BOP facility was determined for one worker. The five brands of half-mask respirators studied were: 3M 8710 disposable dust/mist respirator; Gerson 1710 disposable dust/mist respirator; American Optical 5-Star elastomeric respirator with dust/mist filters (R30); MSA Comfo II elastomeric respirator with dust/mist filters (Type F); and Scott, Model 65 elastomeric respirator with dust/mist filters (642–D).

In general, each participant wore two or more brands, and one WPF was measured per employee per brand worn. One employee had one WPF determined for only one respirator brand. For the elastomeric half-mask respirators, the participants were quantitatively fit tested. A fit factor of 100 or more constituted a pass. Disposable respirators were fit tested using the saccharin qualitative fit test. The overall

study and sampling protocols were discussed by the authors in the foundry portion of the investigation (*see Study 7* discussion above). While not specifically discussed, it is assumed that the same sampling parameters used in the foundry study were in place during this particular study, unless the authors stated otherwise. These assumptions include: composition of the sampling trains was unchanged; individual WPFs were based on monitoring times of one to four hours; elastomeric facepieces were cleaned and inspected at the end of each shift but the insides were not wiped during the shift such wiping was the employer's standard practice before the study; air-purifying filter cartridges and disposable respirators were changed at the end of each shift unless the employer's policy dictated more frequent changing; and the in-mask probe mouth was plugged whenever the respirator was not being worn. In addition, it is assumed that the participants were clean shaven, normally used respirators, were trained in the proper donning and adjustment of the respirators, were instructed not to remove or lift the respirator from their face in the work area, and were observed throughout the sampling period.

The inside-the-facepiece sampling train was a closed-face 25 mm cassette containing a 0.5 micron pore size polyethylene filter and polypropylene backup pad. A reducing ring under the filter restricted airflow to an 18 mm circle in the center of the filter to aid in PIXE analysis. A heating bonnet was slid over the outside of the cassette to minimize condensation of moisture from exhaled breath. This cassette was attached directly to a flared mouth probe, inserted into the respirator opposite the mouth. Sampled air was drawn through a moisture trap using a personal sampling pump operating at 1.5 Lpm. The outside-the-facepiece sampling train was a closed-face 25 mm cassette containing a 0.5 micron pore size polyethylene filter and polypropylene backup pad. A reducing ring under the filter restricted airflow to an 18 mm circle in the center of the filter. The cassette was not connected to a flared mouth probe. This sampling train was attached in the lapel area and samples were collected at a flow rate of 1.5 Lpm. (Note: Unlike the foundry portion of the study, outside samples were collected as total mass rather than respirable mass samples.) Sampling pump flows were calibrated before and after each sampling period and pumps were monitored at approximately 15–20 minute intervals. Respirators were

donned and doffed, and sampling trains were started and stopped, in a clean area. New cassettes were used for each sampling period. Working (*i.e.*, field) blanks and manufacturer's (media) blanks were used to determine possible contamination of filters due to handling or manufacturing. The investigators also washed the interior of the sampling cassettes to determine retention of sample particles on the cassette wall. The ambient particle size distribution was determined by PIXE cascade impactor samples. Personal impactor samples, rather than area samples, were collected at the steel mill sites (*see foundry sampling procedures discussed above in Study 7*).

Analysis for Fe and Ca on inside-the-facepiece filters was by proton induced X-ray emission analysis (PIXEA). Due to filter overloading, analysis for Fe and Ca on outside-the-facepiece filters was by atomic absorption spectroscopy. The mass distribution of Fe by particle aerodynamic diameter was tabulated for all cascade impactor samples. A total of 54 individual pairs of inside- and outside-the-facepiece concentrations, and the corresponding WPFs, were provided by shift and date, job category, employee, and brand of respirator. For 16 workers, the WPFs reported were based on the Fe data, while Ca data were used to calculate the WPF for one worker (flux unloader) in the BOP facility. Based on analytical information, the authors did not adjust measured values for particle retention on the walls of the sampling cassette. No mention is made of adjusting inside-the-facepiece values for particle retention in the respiratory tract. The average field blank mass loading was used as a correction factor for estimating background contamination. The 3M 8710 had a reported GM WPF of 377, a GSD of 3.7, and a fifth percentile WPF of 44. The Gerson 1710 had a reported GM WPF of 123, a GSD of 2.7, and a fifth percentile WPF of 24. The American Optical elastomeric half-mask had a reported GM WPF of 280, a GSD of 2.7, and a fifth percentile WPF of 56. The MSA Comfo II had a reported GM WPF of 427, a GSD of 4.3, and a fifth percentile WPF of 39. The Scott elastomeric half-mask had a reported GM WPF of 252, a GSD of 2.9, and a fifth percentile WPF of 45. The authors concluded that “The 5th percentiles for the WPF distributions for each respirator or pooled data were greater than 20.”

The authors also provided data and discussion on a number of sampling analyses, including GM concentration of analyte and GM WPF by job task, GM concentration of Fe inside the facepiece