

exposed to daily. Workers in dog, rodent, and washroom areas were monitored for 5 working days to determine if a noise hazard existed and risk to the employee.

Results of the study indicated that many of the workers in this study were exposed to noise levels above the 85 dBA TWA over an 8-hour period. Of the 108 values obtained, 65 were above the TWA of 85 dBA. Of these 65 values, 48 were above the OSHA PEL of 90 dBA 8-hour TWA. Workers in the cage wash area and those working with dogs were most likely to be overexposed. None of the employees working with rodents were overexposed in this study. The highest sound level readings were associated with the dogs (95-105 dBA) and the wash area (82-90 dBA).

Recommendations for this study included inclusion in a hearing conservation program for all person working in the dog handling areas and cage wash areas, engineering controls for the washrooms such as rubber mats for floors and grate areas.

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**A CHARACTERIZATION OF OCCUPATIONAL EXPOSURES TO CRUMB RUBBER MODIFIED ASPHALT AND CONVENTIONAL (NONRUBBER CONTAINING) ASPHALT DURING ROAD PAVING.** G. Burr, A. Miller, NIOSH, Cincinnati, OH

Between 1994 and 1997, seven health hazard evaluations were completed as part of an inter-agency agreement between the National Institute for Occupational Safety and Health (NIOSH) and the U.S. Department of Transportation, Federal Highway Administration (FHWA). These surveys, performed in Michigan, Florida, Indiana, Arizona, northern and southern California, and Massachusetts to evaluate occupational exposures among asphalt paving workers, had the following objectives: (1) characterize occupational exposures to crumb rubber modified (CRM) asphalt and conventional (nonrubber containing) asphalt during road paving; (2) develop and field test new sampling and analytical methods; and (3) identify potential health effects associated with CRM asphalt and conventional asphalt exposures. This paper summarizes the occupational exposures measured during these surveys.

At each site, full-shift personal breathing-zone (PBZ) samples were collected on the paving crew (typically 6 to 10 workers) for total particulate, benzene soluble particulate, polycyclic aromatic compounds, and sulfur-containing compounds (including benzothiazole, a sulfur-containing compound present in rubber tires). Benzothiazole was of interest since it may be useful as a surrogate indicator for other CRM asphalt fume exposures. Area samples were also collected over the screed auger and at background locations. Job tasks included paver, screed, and roller operators; rakers; and laborers; and all study participants were evaluated over 4 days (2 days with each type of asphalt paving). Samples were also collected for volatile organic compounds (VOCs), carbon monoxide (CO), hydrogen sulfide (H<sub>2</sub>S), sulfur dioxide (SO<sub>2</sub>), and ozone (O<sub>3</sub>).

All PBZ air concentrations of asphalt fume were below the current NIOSH recommended exposure limit (REL) of 5 mg/m<sup>3</sup> (measured as total particulate). The average exposures for

paver, screed auger, and roller operators, although varying between sites and job tasks, were generally higher during the CRM asphalt paving than during conventional asphalt paving, a trend that was also observed with the area air samples. Benzothiazole, as expected, was generally detected only during CRM asphalt paving. Concentrations of toluene, xylene, methyl isobutyl ketone, and benzene (analyzed because they were the most significant peaks in a qualitative scan of the asphalt fume) were typically less than 1 ppm, and total hydrocarbons, reported as Stoddard solvent, were well below the NIOSH REL of 350 mg/m<sup>3</sup>. Area concentrations of CO ranging up to 1000 ppm were measured where gasoline-powered equipment (such as vibrating tampers or portable generators) was in use, suggesting that some workers could be exposed to CO concentrations in excess of the NIOSH ceiling limit of 200 ppm. Concentrations of HS and SO<sub>2</sub> were not detected, and O<sub>3</sub> was present at background concentrations.

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**USE OF EFFECTIVE TEMPERATURE IN A HEAT STRESS ADVISORY SYSTEM.** W.E.J. McDowell, Occidental Chemical Corp., Pasadena, TX; M. Stenzel, K. Beckner, Occidental Chemical Corp. Dallas, TX

This report presents a methodology for the prediction of heat stress levels so that daily work can be planned and suitable controls predetermined. The Heat Stress Advisory System is a method to quantify risk for work that will be performed under a variety of external influences, including outdoor and indoor situations. An overall quantification is made from known or predicted relative humidity and ambient temperature, and by having a mechanism available to estimate radiant heat load either directly or indirectly through a modeling technique validated with direct measurements.

The effective temperature (ET) is calculated from predictive measurements of ambient temperature and relative humidity (e.g., local weather service). Wet bulb is read directly from a psychrometric chart and a nomogram is then used to determine the effective temperature at a given speed. Severity levels, or ranges of ET, have been established that correspond to specific actions or requirements at the field level. Provisions have been made to increase the severity level by 1 for additional personal protective equipment requirements. The predicted severity level is prominently posted prior to the start of the workday. Supervisors and workers are trained in the definitions of the various work and precautionary categories. For example, Severity Level III corresponds to an effective temperature range from 82.6 to 85.5. For light work, no special precautions are necessary; for moderate work, standard precautions are necessary. For heavy work less than 90 minutes, standard precautions are adequate. Whereas, for heavy work longer than 90 minutes a combination of standard and heightened precautions are required. Use of a Heat Stress Advisory System serves to keep workers aware of the possibility of special work precautions due to heat stress as well as provides a measure for supervisors to determine easily when work schedules may need to be reassessed.

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**ESTIMATING THERMAL DECOMPOSITION PRODUCTS OF ROSIN-CORE SOLDER USING ABIETIC ACID, TOTAL PARTICULATE, AND FORMALDEHYDE AIR SAMPLING.** C. Hoffman, D. Lillquist, C. Lewis-Younger, J. Reading, Rocky Mountain Center for Occupational and Environmental Health, Salt Lake City, UT

This study assessed current methods of measuring exposure to the multiple thermal decomposition products of rosin-core solder. A controlled laboratory setting was used to general aerosol from four quantities of solder. Triplicate runs consuming 2, 5, 10, and 20 grams of solder in an enclosed Plexiglass case were sampled. Three air samples for abietic acid, total particulate, and formaldehyde were performed for each simultaneously over a 25-minute sampling period for each run. Sample results for formaldehyde were all less than the analytical limit of detection. The average sample results for total particulate from each of the four solder masses consumed were 150.67 mg/m<sup>3</sup> (SD = 8.33 mg/m<sup>3</sup>), 300.67 mg/m<sup>3</sup> (SD = 45.5 mg/m<sup>3</sup>), 632 mg/m<sup>3</sup> (SD = 18.9 mg/m<sup>3</sup>), and 858.8 mg/m<sup>3</sup> (SD = 116.5 mg/m<sup>3</sup>), respectively. The sample results for abietic acid were 256 mg/m<sup>3</sup> (SD = 24.98 mg/m<sup>3</sup>), 449.3 mg/m<sup>3</sup> (SD = 53.12 mg/m<sup>3</sup>), 946.67 mg/m<sup>3</sup> (SD = 92.38 mg/m<sup>3</sup>), and 1053.3 mg/m<sup>3</sup> (SD = 184.8 mg/m<sup>3</sup>), respectively. Abietic acid concentrations were higher (122-170% higher) compared with the total particulate. Results show that measurable airborne levels of abietic acid are associated with thermal decomposition of rosin and the amount of solder consumed correlates (r = .88) to abietic acid emissions during soldering operations. The results reveal that abietic acid is superior to formaldehyde and are suggestive that abietic acid is superior to total particulate as a measure of exposure to the thermal decomposition products of solder rosin.

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**BETTER METHODS FOR LOCATING UNDERGROUND UTILITIES.** T. Mustard, M. Loshak, Parsons Engineering Science, Inc., Denver, CO

The United States has nearly 14 million miles of underground pipelines, cables, and wires. Accurately locating underground utilities is vital for worker and community safety and for avoiding unnecessary construction delays and cost impacts. Traditionally, underground utilities have been located by contacting utility companies, property owners, or utility locating services.

Recently, a group of subsurface utility engineering (SUE) firms has emerged, raising utility locating to a state-of-the-art practice. SUE firms have helped to improve safety, speed up project design, avoid costly delays, and minimize change orders on construction projects.

This paper summarizes emerging technologies for locating underground utilities. Two particular procedures are being successfully implemented: air vacuum extraction and electronic line tracing. Air vacuum extraction has been used effectively to determine the exact horizontal and vertical location of utilities. Electronic line tracing uses methods such as ground penetrating radar and electromagnetic frequency line detectors to produce three-dimensional, computer-aided-drafting utility location maps. Both methods have been helpful

**Abstracts**

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