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in 2015. Monitoring data with input for an industry specific task force was requested to assist with investigation of potential workplace exposure controls.

Resolution: Specific knowledge of oilfield operations by health and safety personnel is vital for representative assessment of occupational airborne exposures of tank gauging job positions and general work site monitoring within these environments. Published sampling and analytical methods were employed in addition to field site use of calibrated direct-reading instruments to obtain benzene and hydrocarbon exposure data to assess existing work practice controls.

Results: Exposure assessment monitoring for defined airborne chemicals related to the variable oilfield occupational environment involving tank gauging operations is necessary for specific hazard identification and evaluation procedures. Industrial hygiene monitoring results are compared with current OSHA regulatory standards and other published technical recommended guidelines to better assess and manage the existing potential for elevated workplace airborne exposures. Worst-case grab samples with calibrated direct-reading instruments were also recorded for defined field site work activities and noted weather conditions.

Lessons learned: A range of industrial hygiene techniques were utilized to provide workplace assessment and oilfield site investigation of existing hydrocarbon exposures. Specific airborne monitoring procedures involving referenced methodologies along with subsequent data interpretation assisted with outlined HSE evaluation needs and provided data documentation to assess employee protection and proper hazard management. Investigation of further process design and control measures was also conducted for limitation of existing occupational airborne exposures and provision of useful information for employee protection.

SR-403-03

Characterization of Naturally Occurring Airborne Diacetyl Concentrations Associated with the Preparation and Consumption of Unflavored Coffee

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Objective: Diacetyl, a suspected cause of respiratory disorders in some food and flavorings manufacturing workers, is also a natural component of roasted coffee. The purpose of this analysis was to characterize diacetyl exposures that could plausibly occur in a small coffee shop during the preparation and consumption of unflavored coffee.

Methods: The study was conducted in duplicate, with one simulation in the morning and one in the afternoon, each with a total duration of 3 hours. Airborne samples were collected for 3 hr. (long-term) or 15 min. (short-term). Personal (long- and short-term) and area (long-term) sampling was conducted while a barista ground whole coffee beans, brewed, and poured coffee into cups. Simultaneously, long-term personal samples were collected as two participants, the customers, drank one cup of coffee each per hr. Air sampling and analyses were conducted in accordance with the OSHA Method 1012.

Results: Diacetyl was detected in all long-term samples. The long-term concentrations for the barista and area samples were similar, and ranged from 0.013-0.016 ppm; long-term concentrations for the customers were slightly lower and ranged from 0.010-0.014 ppm. Short-term concentrations ranged from below the limit of detection (< 0.0047 ppm) to 0.016 ppm. Mean estimated 8 hr. time-weighted average (8 hr. TWA) exposures for the barista ranged from 0.007-0.013 ppm. These values exceed recommended 8 hr. TWA occupational exposure limits (OELs) for diacetyl and are comparable to long-term personal measurements collected in various food and beverage production facilities. The concentrations measured based on area sampling were comparable to those measured in the breathing zone of the barista. Exceedances of the recommended OELs may also occur for coffee shop workers who do not personally prepare coffee (e.g., cashier, sanitation/maintenance).

Conclusions: These findings suggest that the practicality and scientific basis of the recommended OELs for diacetyl merit further consideration.

SR-403-04

Occupational Exposure to Vapor, Gas, Dusts, and Fumes Among Rural Residents

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Objective: Occupational histories combined with a job exposure matrix (JEM) can be used to assess work-related exposures when direct measurements are not available. The objectives of this study were to use the occupational histories of adult participants in the Keokuk County Rural Health Study to describe the distribution of jobs among rural residents and their occupational exposures to vapor-gas, dusts, and fumes (VGDF).

Methods: The Keokuk County Rural Health Study was a long-term prospective cohort study of residents living in a rural county in the US state of Iowa. Data collection was conducted in three rounds, each lasting 5 years, between 1994 and 2011. Over the three rounds, 1,893 adult participants completed study questionnaires that included an occupational history documenting all jobs since age 12. US Census 2000 occupational codes were assigned to all reported jobs and combined with a JEM for airflow limitation to yield exposure levels of never/low, medium, or high for total VGDF. We assigned an exposure level for each participant based on the last job in their occupational history.

Results: The combination of the farm, fishing, and forestry occupational group with farmers and farm managers from the management group accounted for 20.5% of participants at last job. The next four most common occupational groups were office and administrative support (14.0%), sales (9.0%), production (7.7%), and education, training, and library (6.3%). The 20.5% of participants in farming, fishing, and forestry jobs was considerably greater than the comparable national figure of 1.3% from the 2000 US Census. For VGDF exposure in last job, the distribution of participants in the high, medium, and never/low exposure categories was 28.1%, 17.8%, and 54.1%, respectively. This is in contrast to findings from a predominantly urban population where the distribution by the same exposure categories based on the last job was 5.3% high, 9.8% medium, and 85.0% never/low.

Conclusions: These results suggest that the unique work history (e.g., farming and other manual labor) of rural residents may lead to higher occupational exposures to VGDF. We will be using the assigned occupational exposures in an upcoming study to investigate whether they are associated with decrements in the spirometry of adults living in a rural county, in order to inform strategies for prevention.

CS-403-05

Options for the Placement of Breathing Zone Air Samples Inside a Welder's Helmet

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Situation/Problem: Breathing zone air sample placement during welding job tasks presents a challenge inside welding helmets. The OSHA Directorate of Compliance Programs states that the correct placement for air samples is near the breathing zone of the employee. Furthermore, the OSHA Technical Manual for Personal Sampling states, "when sampling for welding fumes, the filter cassette must be placed inside the welding helmet to obtain an accurate measurement of the employee's exposure". The American Welding Society also recommends placing the sample inside the helmet. The issue is where to place the sample inside the helmet so it doesn't interfere with the welder's work and comfort.

Resolution: This study presents two options for the placement of air samples inside a welder's helmet that are acceptable to working welders. One option is to clip the sample on a bandana that is tied around the neck. The second option is to clip the sample on a welder's skull cap so it hangs down and along the cheek between the nose and mouth. Employee feedback on the two options indicated they were user-friendly and did not disturb the welder or hinder their job tasks.

Results: Five different welders in 3 separate workplaces were sampled. Side-by-side monitoring was conducted using the bandana and skull cap locations during Gas Metal Arc (GMAW) or MIG welding. NIOSH Method 7303 was followed for air sampling and laboratory analysis. Manganese data was selected for statistical analysis as it is the component of welding fume that is of most concern when welding carbon steel. Statistics computed for the bandana sample data and the skull cap sample data validated this study's proposed sample locations.

Lessons learned: Secure the bandana sample to the welder's shirt so it stays securely inside the helmet. Coach the welder to keep the bandana sample tucked inside the welding helmet. Consider the possibility of skin irritation from sweat, dirt and welding fume accumulation on the bandana. One out of five sampled welders mentioned this concern.

CS-403-06

A Quantitative Model to Predict Allergic Contact Dermatitis from Wearable Technology Products

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Situation/Problem: Wearable products with electronic components are being introduced to consumers without formal biocompatibility testing or health risk assessment. Some products that assess physiological functions involve prolonged skin contact with plastic and metal components under occluded conditions. Recent media reports have described occurrences of skin reactions such as allergic contact dermatitis (ACD) from wearable technology products. These products therefore present a new product stewardship challenge.

Resolution: A quantitative risk assessment model was developed that incorporates estimates of both dermal exposure and ACD elicitation risk. Product prototypes were tested in artificial sweat solution for varying time periods to reflect product-specific dermal exposure use scenarios. Leachates were analyzed for sensitizing metals and organic chemicals to derive potential applied dermal dose or load (in $\mu g/cm^2$/unit time) per sensitizing chemical. To estimate ACD risk per chemical, a nickel ACD-elicitation risk model was developed using published human patch test nickel data. The reported fraction of sensitized user populations exhibited ACD reactions at specified dermal nickel loads. This nickel distribution was then generalized to predict ACD risk for chemical sensitizers with limited patch test data. Prediction was based on the observation that estimated distribution of population sensitivity to nickel is similar to distributions of patch test dose response data for other sensitizing chemicals.

Results: Results indicate that the sensitizing metals (nickel, chromium, and cobalt), and sensitizing organics (primarily acrylate and epoxy compounds) are leached from a variety of tested wearable product prototypes. Dermal loads were estimated to range from <1 to >50 $\mu g/cm^2$/week with chemical loads potentially posing a wide range of risks of ACD reaction in sensitized users, with $<0.01\%$ to $>10\%$ of the sensitized users expected to react.

Lessons learned: This methodology can help manufacturers in identifying components of wearable technology products that pose a high risk of leaching and consequent ACD reactions, in order to make their products biocompatible prior to introduction into consumer markets.

SR-403-07

A Bayesian Approach for Summarizing Real-Time Exposure Data with Left Censoring

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Objective: Direct-reading instruments are valuable tools for measuring exposure. They provide real-time data and valuable information on short-term exposure variability. However, statistical analysis is complicated by autocorrelation among successive measurements, nonstationary time-series, and presence of left-censoring due to limit-of-detection (LOD). A Bayesian framework is proposed for analyzing exposure time-series that accounts for nonstationary autocorrelation and LOD issues.

Methods: A spline based approach was used to model nonstationary autocorrelation with relatively few assumptions about autocorrelation structure. Left censoring was addressed by integrating over the left tail of the distribution. The model was fit using Markov-Chain Monte Carlo within a Bayesian paradigm. The method can flexibly account for hierarchical relationships, random effects and fixed effects of covariates. The method was implemented using the rjags package in R and is illustrated by applying it to real-time exposure data.