Podium Session 129: Exposure Assessment: New Techniques, New Strategies, New Perspectives

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Tools and Techniques for Completing Comprehensive Exposure Assessment in a Large Enterprise

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When faced with assessing the risk of chemical and noise exposures for the myriad of tasks in a large, complex enterprise, the job can initially be overwhelming. Yet it is essential for properly evaluating risks and understanding exposures, for allocating resources and prioritizing controls to reduce worker exposures when warranted. Industrial hygiene (IH) practitioners at three plants worked together to conduct initial exposure assessment for over 100,000 tasks at their facilities. Methods for organizing, starting, and managing this large endeavor will be presented. Tips will be shared for gathering basic characterization information from existing resources, including engineering, product standards, and supervisors. Techniques will be discussed for sorting the acquired information, building process groups, and consequently significantly leveraging exposure assessment efforts. Proven methods will be presented for building management support to bring in additional IHs to conduct focused, intensive exposure assessment sessions.

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Assessing Pharmaceutical Containment Equipment Using Surrogate Monitoring

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This presentation will discuss the use of surrogate monitoring to assess the effectiveness of containment equipment and devices intended to control operators' exposures to active pharmaceutical ingredients (APIs). Manufacturers of solid-dose pharmaceuticals have a need to determine whether control technologies under consideration or in use are adequate to control operators' exposures during handling and processing of APIs. Surrogate monitoring can be a useful method to evaluate containment performance without potential exposures to potent APIs as well as in situations where appropriate monitoring and analytical methods have not been developed for the API of interest. The presenter will discuss use of lactose, naproxen sodium, and other common surrogate materials that are used in place of potent APIs to evaluate the effectiveness of equipment and devices, such as open-faced flow hoods, isolators, material transfer valves, enclosures, and dust control units. Selection of an appropriate surrogate material, test-area considerations, and monitoring equipment, methods and strategies will be addressed.

The surrogate monitoring approach can be used to evaluate different types, makes, and models of equipment and devices before purchase as well as to verify performance upon installation. The monitoring results provide a means of estimating how effectively the equipment will contain the APIs during actual operations, and they can help support assumptions made in control banding strategies. The information included in this presentation can be beneficial for industrial hygienists, process engineers, and others responsible for selection or evaluation of pharmaceutical containment equipment and devices.

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A Strategy for Identifying Tasks for Dust Control Priority by Field use of Direct-Reading Aerosol Instruments

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In moving toward a task-based exposure assessment and management system, the challenge arises of assessing and validating exposures that are infrequent, nonroutine, or of short duration. A task-based sampling strategy offers a powerful complement to full-shift sampling due to the ability to identify tasks that contribute the majority of exposure in a full shift. Yet, for airborne chemical exposures, in many cases the tasks may be too short for collecting the minimum quantity required by the analytical method. Direct-reading instruments have the advantage of delivering real-time results and providing the industrial hygienist with a relative indication of the tasks that contribute the most to a worker's full-shift exposure profile. This presentation discusses the use of direct-reading aerosol instruments to evaluate respirable

dust. Tasks with the highest overall contribution to full-shift exposure are identified. With the ultimate goal of reducing a worker's total exposure, this strategy is effective for pinpointing and prioritizing tasks for exposure control.

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Calculating Average Airborne Concentrations from and Generation Rates for Emissions for Constant Short-Lived Sources

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It has been previously asserted that modeling plays a vital role in exposure assessment. Indeed, models are used both consciously and subconsciously by most practicing hygienists in rendering professional judgment regarding exposure scenarios. Recently conducted studies indicating that the majority of exposure assessment decisions are made without sampling data support these assertions. Model developers and users have also decried the need to develop this very young, crude science. The development of better models and systematic development of parameters such as emission factors are just two such areas in need of further development. This talk will present a solution for calculating the average airborne concentrations from, and generation rates for, constant, short-term emission sources. It will demonstrate that it is very useful and often necessary for calculating G from monitoring data in well mixed boxes from sources that start at t=0 and end before or around the elapsed time necessary to achieve Csat. Finally, using a case study involving particulate, the presentation will demonstrate how G determined in this manner can be used anywhere in many other models.

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Complexities of Hexavalent Chromium Exposure Monitoring — Consultant's Perspective

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The OSHA permissible exposure limit (PEL) for hexavalent chromium (CrVI) was recently

reduced from 52 µg/M^3 to 5.0 µg/M^3 with an action level of 2.5 µg/M^3. This reduction and other requirements of the new CrVI standard have resulted in updates of exposure assessments. Typical monetary and logistical constraints not infrequently limit the number of samples collected and scenarios that can be considered. A common approach is to develop and select worst-case scenarios, which include monitoring employees and tasks believed to represent the highest potential for exposure. CrVI monitoring poses a unique challenge based on numerous presumed independent variables that can theoretically influence sample results. In considering welding, some of the variables that are considered are the welding process, material, workspace configuration, work process, ventilation, welder's speed/arc time, and sample media placement. Two welding case studies are presented. Case 1 includes two welders who worked with 309 stainless steel for an entire 8-hr shift. The welding tasks included shielded metal arc welding (SMAW) and gas tungsten arc welding (GTAW). Results were at or below the action level for both workers. Case 2 included two welders who performed 1.5 hr of SMAW with stainless 309. Case 2 results were above the PEL for both employees and higher than the Case 1 results for those who worked with stainless for 8 hr. There were a number of variables which may have influenced the findings and could have resulted in misclassification of a "worste case scenario." One role of the industrial hygienist is to consult with employers and understand range-of-exposure scenarios as well as the extent and complexity of variables that may influence results. It is also important to determine if the objective is compliance or a more broad exposure assessment.

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Historical Benzene Exposure Reconstruction: Refinery Workers at ExxonMobil Refinery, Baton Rouge, Louisiana

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Historical exposures to benzene were quantified for workers at the ExxonMobil Baton Rouge, La., refinery from 1978 to 2005. The purpose of this study was to understand the variability in workers' benzene exposures over time, throughout the facility and during different job tasks. The ExxonMobil industrial hygiene (IH) exposure assessment program was used to group

workers' exposures by normal refinery operations, turnarounds, and specific job tasks. Approximately 100 worker exposure groups were identified and associated with approximately 132 different job tasks. Because the dock workers had exposures to benzene due to refinery operations as well as the chemical plant, they were analyzed separately. The results of more than 3500 IH air samples were evaluated for inclusion in this analysis. Approximately 2300 long-term (>2 hr) personal samples and approximately 900 short term (<2 hr) personal samples were considered. Area samples were also identified but used only to estimate exposures if no personal samples were available. The air sampling dataset was lognormally distributed. In general, the long-term personal samples showed a decreasing trend in benzene air concentrations over time. The geometric mean, median, and 95-percentile value of long-term samples for all workers at the site were approximately 0.02, 0.01, and 0.2 ppm, respectively, for the 27-yr period. The geometric mean, median, and 95-percentile value of the short-term samples were approximately 0.08, 0.07, and 0.8 ppm, respectively. The majority of the short-term samples and many of the long-term samples were collected to evaluate benzene exposures during specific tasks and activities that involved benzene containing refinery process streams. The results were compared to the contemporaneous occupational exposure limits. For the vast majority of sampling events, the full-shift personal air sample results were found to be less than the contemporaneous occupational exposure limits for those employed at this refinery.

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Retrospectively Evaluating Employee Exposures During an Accidental Chlorine Release

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Tracer gas technology is ideal for safely recreating chemical release events for evaluating alleged retrospective employee exposures. Sulfur hexafluoride (SF6), the tracer gas of choice, is colorless and odorless and has a threshold limit value of 1000 ppm. Most simulated chemical exposure events use levels in the ppb to very low ppm range. In this case study, tracer gas technology was used to recreate an accidental chlorine gas release and model an employee's exposure. The recreation and modeling was requested as part of a workers' compensation claim alleging permanent health damage from the exposure. The accidental chlorine release was from the exhaust of a process chamber of a computer chip manufacturing tool that had undergone a maintenance procedure during which the exhaust had not been reconnected. Thirty seconds after the tool was turned on, the operator realized that chlorine was being discharged from the device's exhaust into the basement work environment below the computer chip fabrication shop. The operator immediately shut down the operation and the area was evacuated. Shortly thereafter, one employee of 10 in the surrounding area alleged overexposure to chlorine gas and was hospitalized. The employee later filed a workers'

compensation claim alleging permanent health damage from the exposure. Due to the computer chip manufacturing tool's computer software, the exact duration of the chlorine release and flow rate was known. Given this information, the accidental release was recreated with the tracer gas, and a model was developed to assess potential employee exposures in the surrounding areas. The recreation demonstrated that the likely exposure of the most highly exposed individual would not have exceeded 0.2 ppm of chlorine even during 90-sec release (3 ´ times longer than the estimated worst-case release). This was below the odor threshold and consistent with the interview findings.

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Exposure Assessment for Metals in a Police Department Firing Range while Using Different Types of Ammunition

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Data was collected during characterizations of a police department firing range for compliance with OSHA standards relative to exposure to lead. Personnel at the firing range include active duty officers and a rangemaster. Data collection began in 1992. This police department contacted the EOHS Division at the University of Illinois at Chicago's School of Public Health, and air sampling and mechanical ventilation measurements were made as part of a student field project. The air sampling found that the lead exposure was significant, and the department replaced the ammunition used in the range with copper-jacketed ammunition. In subsequent years, the department continued to request characterizations of lead exposure whenever it changed target practice ammunition or at least annually in order to maintain a record of IDOL compliance. In total, 10 sampling events occurred over 14 yr. In the latest evaluation, the department had replaced the copper-jacketed ammunition with frangible ammunition. No lead is contained in this ammunition. The bullet is composed of copper, tin, and zinc particulate pressed or heated into the desired shape. The bullet is designed to disintegrate on impact with deflectors located behind the targets. In addition to reducing or eliminating lead exposure, the bullets reduce the possibility of ricochet during target practice and reduce waste disposal costs. However, the air samples were analyzed for copper, tin, and zinc as well as lead, as a service to the department. The results from the characterizations of lead in previous years, as well as the current metals exposures from frangible ammunition, may be of significant interest to the law enforcement, range administration, and safety and health community.

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Assessment of Dermal Exposures at Three Cemented Tungsten Carbide Facilities

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A recent NIOSH survey identified an excess prevalence of asthma among workers at three cemented tungsten carbide (CTC) facilities. Prevalences were highest among workers in milling, spray drying, pressing, sintering, and product testing, compared to all other areas. There was no clear evidence of a total cobalt mass-based inhalation exposure-response among these workers. Cobalt, in ionic form, can permeate human skin. Thus we hypothesized that the skin may be an important route of cobalt exposure that leads to occupationally-induced asthma. The purpose of this study was to evaluate levels of cobalt on work surfaces and on employees′ skin in work areas that confer excess risk of asthma relative to lower-risk work areas at these three facilities.

Over a six-day period, we collected wipes from routinely handled work surfaces (n=156) and from the hands (n=114) and necks (n=114) of employees in 26 work areas, 3 of which were associated with higher asthma risk. Median levels of cobalt on work surfaces were lowest at the facility involved with metal separation and production of tungsten carbide powder (137 µg/100 cm2); higher at the facility that forms, shapes, sinters, and grinds final CTC product (246 µg/100 cm2); and highest at the facility that mixes, mills, spray dries, and screens CTC powders (670 µg/100 cm2). Median masses of cobalt on employees′ hands were 154, 94, and 489 µg, and on employees′ necks they were 25, 5, and 90 µg. Cobalt levels on skin were not substantially different among work areas. Results of this study demonstrated measurable levels of cobalt on the skin of CTC workers. Based on our current understanding that multiple routes of exposure may lead to occupationally induced asthma, these data support prudent control practices, such as use of protective gloves, to minimize cobalt skin exposure in the workplace.

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Benzene Exposures from Petroleum-Derived Solvents Containing Trace Levels of Benzene in Occupational Settings

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Benzene may be present as a trace impurity or residual component of mixed petroleum solvents due to refining processes. In this presentation, we review the physical and chemical properties of various petroleum solvents and characterize the typical airborne concentrations of benzene associated with the handling or use of low-level benzene-containing products in the United States. Our assessment was based on (1) a review of the benzene content and flammability hazard of various petroleum solvents; (2) a review and synthesis of the publicly available literature on measured airborne concentrations of benzene associated with products that have typically contained <0.1% benzene since the late 1970s or early 1980s; and (3) indoor exposure modeling to predict breathing zone 8-hr time-weighted average (TWA) airborne concentrations of benzene under several hypothetical scenarios involving the use of benzene-containing mineral spirits. Our analysis showed that petroleum-derived products that may have historically contained trace levels of benzene, such as paints and paint solvents, printing solvents and inks, cutting and honing oils, adhesives, mineral spirits and degreasers, and jet fuel, could have produced average TWA airborne concentrations of benzene that ranged from 0.002 to 0.2 ppm under standard use scenarios. Higher air concentrations (up to 1 or 2 ppm benzene) have occasionally been reported for specific products, particularly if the bulk content of the product was unknown (or suspected of being greater than 1%) or the sampling was performed under worst-case solvent use patterns or workplace conditions. The overall weight-of-evidence indicates that only certain low volatility solvents (such as mineral spirits) can be safely used in spray applications or unventilated workplace conditions. It also indicates that, under nearly all anticipated product use scenarios, petroleum-based products containing <0.1% benzene are not expected to produce 8-hr TWA airborne concentrations that exceed current occupational exposure limits.

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Assessment of Asbestos Exposures from Airplane Piston Engine Overhaul and Service Work

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The purpose of this study was to characterize the airborne asbestos exposures of mechanics performing overhaul and service work on airplane piston engines. The sources of asbestos in these engines are various gaskets, seals, wiring insulation, and clutches. This study was conducted at a Federal Aviation Administration certified airplane piston engine service facility. It was performed by experienced airplane piston engine mechanics, with the tools, materials, and work practices that have been in use since this engine type was produced. The engine used was a Pratt & Whitney R-2800. Bulk samples were collected and analyzed from all types of materials that potentially could have been asbestos-containing from parts removed and

parts installed in accordance with EPA Method 600/R-93/116. All personal and area air samples were collected and analyzed in accordance with the NIOSH Methods 7400 and 7402. Results of bulk sampling showed that 40% of the potential asbestos-containing parts were positive for the presence of chrysotile asbestos. The percent asbestos present in the samples ranged from 20% to 70%. Results of personal air samples analyzed by phase contrast microscopy (PCM) showed a mean and maximum 8-TWA fiber concentration of 0.0093 f/cm3 and 0.040 f/cm3, respectively. Transmission electron microscopy (TEM) analysis showed that only 1 of 121 personal samples contained asbestos, and only 1 chrysotile asbestos fiber was found in this sample. Results of area air samples analyzed by PCM showed a mean and maximum 8-hr time-weighted average concentration of 0.0026 f/cm3 and 0.011 f/cm3, respectively. TEM showed that only 5 of 88 area samples contained asbestos, and a total of 5 chrysotile asbestos fibers was found in these samples. Results of this study provide data that the exposures to asbestos of mechanics who either overhaul or service airplane piston engines are very low or approaching zero.