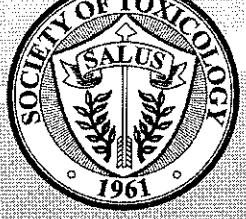

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1990s), and average and upper bound exposure estimates were developed for workers identified as BeS or with CBD. This assessment included the analysis of 3,833 personal lapel and 614 general area samples and other new data collected by plant health and safety staff at the facility. Results of this analysis showed that all workers diagnosed with CBD were exposed to beryllium concentrations of 0.2 µg/m3 (95th percentile) or greater. The prevalence of BeS among surveyed workers exposed below a 95th percentile beryllium concentration of 0.2 µg/m3 was consistent with the anticipated background rate of BeS of 1-2 percent. It was concluded based on this analysis of BeS and CBD workers in a beryllium metal machining plant, concentrations maintained below 0.2 µg/m3 95% of the time will likely prevent BeS and CBD in nearly all beryllium workers.

850 ANALYSIS OF EXPOSURE TO BENZENE IN MINERAL SPIRIT SOLVENTS DURING PARTS WASHING AND DEGREASING OPERATIONS

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Although the primary focus of benzene exposure assessment remains on workers in manufacturing industries producing or using substantial quantities of benzene, recently there have been questions raised about workers exposed outside the manufacturing setting to benzene-containing products. Mineral spirit solvents are one type of benzene-containing product that has drawn attention because of their widespread use in cleaning and degreasing applications such as parts washing. However, there is a paucity of data on benzene concentrations in mineral spirit solvents and in breathing zone air of workers using these solvents during parts washing. This study summarizes previously unpublished benzene data for parts washing activities and provides an evaluation of potential daily and cumulative exposures to benzene associated with the use of mineral spirit solvents in parts washers to those individuals commonly exposed – mechanics. The distribution of the potential total dose for mechanics from inhalation and dermal uptake of benzene from the use of parts washers was calculated using Monte Carlo probabilistic methods. The 50th and 95th percentile of the dose distribution for mechanics performing a single parts washing event during a workday are estimated to be 0.07 and 1.1 mg, respectively. These are equivalent to the dose received from 8-hour time-weighted average benzene concentrations of approximately 0.002 and 0.03 ppm, which are substantially less than the current workplace threshold limit value of 0.5 ppm. Results of the study indicate most of the benzene dose is from inhalation of airborne benzene rather than dermal contact with the benzene in parts washing solvent. Additionally, the 50th and 95th percentile of the distribution of occupational cumulative dose for mechanics working in facilities with parts washing units are estimated to be 0.006 and 0.2 ppm-years, respectively.

851 RECONSTRUCTION OF BENZENE EXPOSURES DURING THE SIMULATED USE OF A PENETRATING AND DE-RUSTING AGENT

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Benzene has historically been found as a contaminant in many industrial and consumer products. The purpose of the current study was to characterize benzene exposures from the use of a common penetrant and de-rusting agent that contained benzene prior to the late 1970s. Specifically, we recreated several product formulations that were similar in physical properties and chemical composition to that used in the past, and measured the airborne concentrations of benzene during the simulated use of these products under various conditions. A total of 219 air samples were collected during 11 product use scenarios, including 15-minute background samples (N=43), 15-minute personal samples (N=88), 1-hour personal samples (N=44), and 1-hour areas samples (N=44). We find that airborne concentrations of benzene varied by 100-fold or more depending on the scenario. Specifically, benzene concentrations were found to range from 0.04-4.9 ppm for all 15-minute personal samples, 0.04-4.1 ppm for all 1-hour personal samples, and 0.01-1.9 ppm for all 1-hour area samples. Airborne concentrations were most heavily influenced by the benzene content of the product (1%, 3%, 14%, 30%) as well as the ventilation rate (low, average, high, outdoors), but were generally not affected by the type of product (historical versus current blend) or quantity of the product used (10 ml vs. 20 ml). We also developed a linear regression model based on the air sampling data which illustrates how several key parameters affect the measured ambient air concentrations of benzene. This model provides a relatively good fit to the data, with the coefficient of variance (R2) ranging from 0.66-0.68 for the personal samples and 0.74 for the area samples. The current study represents the first known attempt to fully characterize the plausible range of benzene exposure levels associated with the past use of this type of product, and provides quantitative data for use in retrospective exposure assessments.

852 RECONSTRUCTION OF EXPOSURE OF SKILLED CRAFTSMEN TO ASBESTOS AT THE BEAUMONT, TEXAS REFINERY (1946-2004)

P. R. Williams[1] and D. J. Paustenbach[2]. [1]*ChemRisk, Boulder, CO and* [2]*ChemRisk, San Francisco, CA.*

Despite attempts over the past 50 years to estimate airborne concentrations of asbestos during selected job tasks or activities, there has been no known attempt to reconstruct asbestos exposures for different craftsmen employed in various (non-manufacturing) industries. We rely upon our extensive review of the literature, coupled with site-specific data and interviews with former workers, to characterize the likely distribution of asbestos exposures for 12 different trades at a petroleum refinery from the 1940s to the present. Specifically, we estimate 8-hour TWA airborne concentrations of asbestos for each trade during six distinct time periods at the Beaumont, Texas refinery using a probabilistic (Monte Carlo) model. The primary trades of interest include insulators, pipefitters, boilermakers, masons, welders, sheet metal workers, millwrights, electricians, carpenters, painters, laborers, and maintenance workers. We find that insulators had the highest estimated exposures, with 8-hour TWA asbestos concentrations at the 50th (and 95th) percentile ranging from 3.1 f/cc (8.4 f/cc) from 1945-1965 to 0.001 f/cc (0.005 f/cc) from 1994-2004 (a 1,000-fold difference). Most other crafts had estimated exposure levels approximately 2-10 times less that that of insulators. The most notable reduction in exposures for all craftsmen occurred during the 1985-1993 time period due to several factors, including the reduction in regulatory exposure limits, increased respirator use and training at the facility, and less time working with asbestos due to the use of substitute products. The two most sensitive input parameters in the Monte Carlo analysis are (1) the task-specific asbestos concentrations which were used to calculate the 8-hour TWA estimates, and (2) the fraction of time spent working with asbestos materials. Despite a number of data limitations, this analysis provides a practical approach for how to conduct an exposure reconstruction assessment and yields specific quantitative exposure estimates that can be used in future investigations involving asbestos.

853 ASSESSMENT OF ASBESTOS EXPOSURE AMONG AUTOMECHANICS SERVICING AND HANDLING ASBESTOS CONTAINING GASKETS

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Asbestos exposures were assessed for a mechanic removing and installing asbestos containing gaskets on automobiles. Three separate test sessions were conducted during which automotive engines were partially disassembled and cleaned of old asbestos containing gasket remnants in preparation for reassembly. Two additional test sessions followed, wherein new asbestos containing gaskets were used during engine reassembly. All testing took place within an automotive repair facility involving passenger cars and a pickup truck ranging in vintage from late 1960's through 1970's. A professional mechanic performed all of the shop work which included gasket removal and parts cleaning. Gasket removal was accomplished via blade scraping and wire brushing. A pneumatically powered drill motor with a twisted wire brush attachment was utilized to dislodge gasket remnants from removed parts and engine receiving surfaces. Within the gaskets identified to contain asbestos using Environmental Protection Agency (EPA) method 600/R-93/116 [Polarized Light Microscopy (PLM)], asbestos fibers concentrations ranged between 70-75% of the gasket material. Personal, area and ambient air samples were collected and analyzed using National Institute of Occupational Safety Health (NIOSH) methods 7400 (PCM) and 7402 (TEM). Among all personal and area air samples collected during the five simulations, approximately 21 % (n=11) contained chryostile fibers. The mean 8-hour Time Weighted Average (TWA) concentrations obtained from PCM and TEM analyses for these samples was 0.0034 fibers/mL and 0.0018 fibers/mL, respectively. Based on these findings, automobile mechanics who worked with asbestos containing gaskets may have been exposed to concentrations of airborne asbestos fibers that are well below the current Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit (PEL) of 0.1 fibers/mL.

854 CHARACTERIZATION OF CHRYSOTILE ASBESTOS EXPOSURES FOR GARAGE MECHANICS

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Numerous epidemiology studies have demonstrated that garage mechanics are not at an increased risk of developing lung cancer or mesothelioma, despite the potential exposures to chrysotile asbestos that could have occurred during vehicle servicing activities when working with brakes, clutches, and gaskets. The purpose of this analysis is to develop conservative, upper-bound estimates of chrysotile asbestos exposure for garage mechanics and compare these to no-effect exposure thresholds

that have been reported for other occupational cohorts exposed to predominantly chrysotile asbestos. Distributions of occupational tenure data were taken from the 1987 Current Population Survey, which provided data on the years worked by mechanics from the 1960s through most of the 1980s. Distributions of airborne chrysotile data were developed from the National Institute for Occupational Safety and Health surveys conducted from 1976 to 1987 in 22 different garage settings. A Monte Carlo analysis indicates that 3 f/cc*year represents the 95th percentile cumulative chrysotile asbestos exposure for garage mechanics in the U.S. A review of the literature shows that this upper-bound exposure is consistent with no-effect exposure thresholds that have been reported for occupational cohorts exposed primarily to chrysotile asbestos. Specifically, reported no-effect exposure thresholds for lung cancer are typically 40 f/cc-year and higher; reported exposure thresholds for mesothelioma were also higher than the 3 f/cc*year estimate for garage mechanics. It is important to note that it is still unclear whether chrysotile is a risk factor for mesothelioma and that any increased risk of mesothelioma reported in the aforementioned "chrysotile only" occupational cohorts may have been due to the presence of amphibole asbestos in the workplace.

855 EXPOSURE TO NATURALLY OCCURRING ASBESTOS DURING OFFROAD VEHICLE AND CAMPING/HIKING ACTIVITIES AT A RECREATIONAL AREA IN CALIFORNIA

D. Stralka, L. Suer and A. Den. *Region 9, US Environmental Protection Agency, San Francisco, CA.* Sponsor: G. Hiatt.

Activity-based personal monitoring was used to measure exposures to naturally occurring asbestos (NOA) during both wet and dry seasons at BLM's Clear Creek Management Area (CCMA) in San Benito County California. Multiple motorcycle, all-terrain vehicles (ATVs) and sport utility vehicles (SUV) riders (3 riders at a time) were equipped with personal monitoring equipment to measure asbestos levels as they rode over a set course at the CCMA similar to known recreational riding routes. In addition personal exposures were monitored during various simulated camping, hiking, fence mending and vehicle cleanup activities. CCMA has been long known for its naturally occurring asbestos (predominantly chrysotile deposits) and the purpose of this exposure effort was to update a similar 1992 sampling effort conducted by BLM. The current effort used an updated counting methodology, ISO 10312 Transmission Electron Microscope analytical method, and assessed exposure to both adult and children during several recreational activities. Children as young as six years old were observed riding the trails. RESULTS: Asbestos was found in all personal and ambient air samples, however personal activities greatly increased exposure. Personal exposures for some of the trailing riders exceeded 1 PCME (phase contrast microscopy equivalent) fibers/cc. The highest personal asbestos exposure was 2 PCME f/cc for a trailing ATV rider during the dry season. CONCLUSIONS: Off-road vehicle activities in areas of CCMA created very high personal exposures from NOA. Those exposures may remain high despite moist soil conditions. Lastly, when sampling heights were lowered to simulate a child riding a motorbike or an ATV the personal exposure levels were higher than the adult.

856 PERSONAL EXPOSURES TO NATURALLY-OCCURRING ASBESTOS DURING SPORTS AND PLAY ACTIVITIES IN A CALIFORNIA COMMUNITY IN THE SIERRA FOOTHILLS

G. F. Hiatt, A. R. Den and J. M. Johnson. *Region 9, USEPA, San Francisco, CA.*

Personal exposures to naturally-occurring asbestos (NOA) were monitored during simulated sports and play activities (hiking, biking, baseball, soccer, basketball, gardening) at 3 public schools and a park in a Sierra foothill community. Sampling occurred over 11 days during the dry season in El Dorado Hills, CA, where NOA is present in areas of intense residential development. Asbestos levels in personal and ambient air samples were measured as PCME (phase contrast microscopy equivalent) fibers using the ISO 10312 analytical method. Personal asbestos exposures (n=5 for each activity) ranged 0.001 to 0.034 f/cc during simulated activities and were compared to ambient stationary samples (n=5 each day; grand mean = 0.0008 f/cc) collected concurrently nearby in the community. Results: Asbestos was detected in almost all personal exposure and ambient air samples. The predominant fiber type was an amphibole of the actinolite-tremolite solid solution series. Simulated sports and play activities created personal asbestos exposures that ranged 2-fold to 62-fold higher than concurrent ambient air levels in the community. The highest asbestos exposures (12-fold to 62-fold higher than concurrent ambient) occurred to participants on bare, natural dirt in a student garden and on a trail used for hiking and biking. Elevated asbestos exposures during sports activities on grass (soccer) and asphalt (basketball) ranged 3-fold to 16-fold higher than concurrent ambient levels. Conclusions: Sampling breathing zone air during simulated activities is a superior technique for evaluating personal asbestos exposures than is stationary air sampling. Typical sports and play activities can create significantly elevated personal asbestos exposures for children in areas where NOA is present. Since amphibole fibers persist in the body for many years and children can be expected to survive the decades-long latency period associated with asbestos-related diseases, this exposure represents a potential public health issue worthy of attention from all stakeholders.

857 RETROSPECTIVE EXPOSURE ANALYSIS OF RESIDENTIAL EXPOSURE TO PERFLUOROOCTANOIC ACID (PFOA) FROM 1951 TO 2003

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Measurable quantities of PFOA have been detected in the drinking water of five communities located near a fluoropolymer manufacturing facility in Washington, WV. The plant has been operational since 1951 and has been investigated as the possible source of PFOA found in the drinking water. A retrospective exposure analysis was conducted to estimate the potential intake of PFOA from 1951 – 2003 by persons residing in the local communities where the drinking water has been affected. Following considerable analyses, particulate deposition from facility air emissions to soil and the subsequent transfer of the chemical through the soil was determined to be the most likely source of the PFOA detected in the groundwater near the facility. A mass balance analysis was conducted to determine the historical releases of PFOA from the plant. Estimates of historical environmental concentrations were made using EPA's ISCST3 air dispersion and deposition model as well as the PRZM-3 model to estimate the PFOA concentrations in surface soil and the movement of the chemical to the groundwater. Estimates of the intake of PFOA by residents were estimated for each water district for various routes of exposure. The highest off-site environmental concentrations were predicted to occur about 1 mile away. For this 1 square mile area, during the time period 1951 -2003, the model estimated air concentration was 0.2 µg/m3, the estimated surface soil concentration was 11 µg/kg, and the estimated drinking water concentration was 3 µg/L. Comparison of measured to modeled PFOA concentrations in groundwater indicated that the models over predicted recent groundwater concentrations by factor of 3 to 5. A margin of exposure (MOE) analysis was conducted to understand potential human health risk to the local residents. The resultant MOEs ranged from approximately 9,000 to greater than one million. As such, based on current toxicity information, adverse health effects from chronic exposure to PFOA in the affected communities would not be expected.

858 NICKEL ABSORPTION FOLLOWING WATER INGESTION IN ADULTS: A PROBABILISTIC APPROACH TO ESTIMATION OF NICKEL BIOAVAILABILITY

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Estimation of health risks associated with exposures to nickel in drinking water requires accurate estimates of nickel bioavailability. Bioavailability of water soluble nickel is higher when exposure occurs in the fasted state than when exposure occurs with meals, and decreases as the time between exposure and the meal decreases. Therefore, average bioavailability of water-borne nickel would be expected to be influenced by variability in the daily temporal patterns of drinking water and meal ingestion. In the current study, we used Monte Carlo simulation and meal consumption data from NHANES III, along with experimentally-derived estimates of changes in bioavailability of nickel in subjects who consumed nickel at various times before or after meals, to derive estimates of a meal-weighted daily average bioavailability of water soluble nickel in the U.S. adult male population. The model predicted meal-weighted absolute bioavailability estimates ranged from a low of 3.4%, for people who ingest 100% of their total daily drinking water intake at meal times, to as much as 17% for people who ingest all of their water between meals. A sensitivity analysis of the meal-weighting nickel bioavailability model indicated that the estimate of the bioavailability of nickel was most sensitive to the parameter that represented the percent of exposure that occurred at meal times and the number of meals eaten per day. The model was not sensitive to the number of exposure events per day, or the intra-individual correlation in absorption fraction.

859 SURVEY OF RECREATIONAL ACTIVITIES ALONG KING COUNTY, WA SHORELINES FOR USE IN SITE-SPECIFIC RISK ASSESSMENT: EXPOSURE DISTRIBUTIONS FOR SEDIMENT AND WATER CONTACT ACTIVITIES AND FISH CONSUMPTION

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Activity pattern surveys are useful tools for reducing uncertainty when defining exposure in a risk assessment. This report presents the results of two site-specific surveys that were used to quantify recreational activity and fish consumption patterns