Occupational exposure to silica dust has historically been known to cause chronic respiratory conditions. Workers and workplaces within agricultural industries remain removed from the attention of occupational health and safety. To date, the identification and degree of exposure of respirable dust, crystalline silica, and endotoxin exposure throughout the potato harvesting process has been uncharacterized. A description of the potential occupational risks in this setting was therefore warranted. The agricultural practices specific to potato harvest, the geographic region, and the soil of the San Luis Valley, are believed to contribute to an occupational risk. The purpose of this research was to identify the components of dust during the fall potato harvest in the San Luis Valley of Southern Colorado. The testing sites were located within three counties of this valley, including seven farming locations. The farm sites were chosen based upon their location, variable soil types, and owner interest. The following parameters were measured: respirable dust, and respirable silica by the 10 mm cyclone; bacterial endotoxin (EU/m^3) by the Limulus amoebocyte lysate test; and scanning electron microscopy for particle identification purposes. All exposures were based on an 8-hour time-weighted average. Exposure impact included the following variables: location of the farming site, soil type (sand, rock, loam), individual job description, weather conditions (wind, rain, wet or dry soil during harvesting operations), humidity, and temperature. Results of air monitoring, and the identification, classification, and quantification of agricultural worker exposure to these risks have been reported with a maximum respirable silica (quartz) of 0.105 mg/m^3 identified, slightly exceeding the ACGIH TLV of 0.10 mg/m^3. This information will allow employers to recognize where silica dust is generated and allow for planning and control implementation to adequately protect workers.

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POLLUTION PREVENTION TO REDUCE WORKER EXPOSURE: ALTERNATIVES TO CHLORINATED CLEANING SOLVENTS. M.J. Ellenbecker, K.B. Thomas, Toxics Use Reduction Institute, University of Massachusetts Lowell, MA

An important source of worker exposure to solvents is parts cleaning. Such exposures typically are reduced by a combination of engineering controls, administrative controls, and personal protective equipment. Recent pollution prevention research, however, has suggested that a far more satisfactory approach, substitution, may be appropriate in many applications including parts cleaning. This paper discusses the results of a specific substitution research project, and the general conclusions that can be drawn about the use of this methodology by industrial hygienists.

This research program investigated the feasibility of nonsolvent alternatives for cleaning metal surfaces at two parts manufacturers and an electroplating job shop. The facilities all used vapor-phase degreasers employing trichloroethylene, 1,1,1-trichloroethane, methylene chloride, and CFC-113. At each facility a complete pollution prevention options assessment was performed, consisting first of options identification followed by technical, financial, and occupational/environmental health and safety (H&S) analyses. Options considered included various aqueous cleaning alternatives such as pressure spray washers, ultrasonic systems and immersion tanks, abrasive blasting, and CO_2 blasting.

Each technical evaluation identified viable nonsolvent alternatives, all of which reduced worker/environmental exposures. The financial analysis results were mixed. There was clear financial benefit to the parts manufacturers; the annualized costs of the new processes were less than the degreasers. Here, the nonsolvent substitution clearly is preferable, since it eliminates worker exposure while saving money. The job shop cleans a variety of substrates and soils, so that several cleaning systems were required to replace the degreaser. The financial analysis indicated that the new systems would be somewhat more expensive, so that there was no financial incentive to make the substitution.

The research reported here offers lessons that can be extended beyond these three companies. These lessons, including the benefits of the pollution prevention approach to industrial hygiene, are discussed fully in the complete presentation.

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EVALUATION OF CONTROLS USED TO REDUCE WELDING FUME EXPOSURES. M. Wallace, NIOSH, Cincinnati, OH

This report summarizes the data collected during a major control technology study of welding operations conducted at seven field sites. The purpose of the study was to evaluate the effectiveness of various engineering control measures in reducing welding fume exposures. Welding parameters varied at each location; however, all used arc welding techniques. Types of arc welding evaluated included shielded metal (stick or SMAW), gas metal (GMAW or MIG), flux cored (FCAW), and gas tungsten (GTAW or TIG). Metals welded included aluminum, mild steel, galvanized steel, and stainless steel. Five studies were conducted at industrial sites, while two studies were conducted at a union training center for welders and at a vocational school. The majority of evaluated control measures were classified as ventilation units, including portable and fixed local exhaust hoods, canopy hoods, and fume extraction welding guns. At one industrial site, rather than using ventilated measures, fume levels were controlled by modifying the process that involved using pulsed arc welding techniques in place of conventional GMAW techniques. During each field study, industrial hygiene air samples were collected to determine total welding fume concentrations and levels of airborne metals. The NIOSH analytical methods for total particulates (0500) and elements (7300) were followed. Additional information on total welding fume exposures was collected using real-time aerosol instrumentation. Results indicated that the ventilated controls ranged from being completely ineffective (a canopy hood system) to very effective, reducing workers' fume exposures by up to 83% (a fume extraction gun system). The process modification control method resulted in a 24% reduction in welding fume exposures. Overall, however, even with controls, exposure levels for total welding fume and metals such as hexavalent chromium, arsenic, and manganese occasionally still exceeded limits set by the ACGIH, NIOSH, and OSHA.

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THE DEVELOPMENT OF CONTROLS AND INK SUBSTITUTES FOR REDUCING WORKPLACE CONCENTRATIONS OF ORGANIC SOLVENT VAPORS IN A VINYL SHOWER CURTAIN PRINTING PLANT. H.V. Piltingsrud, A. Zimmer, NIOSH, Cincinnati, OH; A. Rourke, Ohio Bureau of Workers Compensation, Dayton, OH

During the summer of 1994 there were complaints of noxious odors reported by football players at a practice field located in Cincinnati. During Ohio Environmental Protection Agency (OEPA) investigations of industries surrounding the field, they inspected a printing facility located approximately one-quarter mile from the practice field. The facility produces vinyl shower curtains having screen-printed designs on them. Printing is carried out by means of movable screen printing units, having polyester screens approximately 6 × 6 feet. The printing units move over tables approximately 7 feet wide by 150 feet long. Four printing tables are located side-by-side in a room approximately 50 × 200 × 12 feet high. The OEPA found that they were not the source of the odor in question; however, they were in regulatory noncompliance for uncontrolled volatile organic compound (VOC) discharges to the environs resulting from their use of organic solvents in their printing process. The company was then required to install an air incinerator at the facility to treat discharged air. The cost of such equipment was very high, and the capacity of the incinerator they installed resulted in a reduction in the flow of discharged air to approximately one-third of previous levels, increasing solvent vapor concentrations within the workplace atmosphere to levels exceeding NIOSH, OSHA, and ACGIH acceptable concentration levels for worker exposure. Consequently, workers were required to wear organic vapor cartridge respirators nearly full time. The printing company requested NIOSH assistance in finding methods to reduce solvent vapor exposures. NIOSH studies included the identification of the sources and relative magnitude of solvent emissions from the printing process, the design of controls for solvent emissions from the printing process, and the development of substitute inks using nonphotochemically reactive (as defined by the OEPA) solvents. Controls included the enclosure of the movable printer units to suppress evaporation of solvents from the printing screen. The NIOSH-developed ink used lower evaporation-rate solvents, having TLV values >100 ppm. Their nonphotochemically reactive status allowed OEPA removal of the requirement for the incineration of discharged air. This allowed substantial increases in dilution ventilation, enabling a reduction in worker exposures to less than one-third TLV additive levels, and a consequential removal of requirements for respirator usage. The solution was the result of a comprehensive review of all facets of the problem, including OEPA regulations. It also

required teamwork with the company, The Ohio Bureau of Workers Compensation, and the OEPA.

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A PROVINCIAL PROGRAM IN THE COMPOSITE PLASTIC INDUSTRIES IN QUEBEC. C. Lemieux, CSST, Quebec, PQ, Canada

The composite industry (reinforced plastics industry) is an economic sector of high growth in Quebec, having doubled its activities in the last decade.

The manufacturing process most currently used is open molds with hand lay-up or manual or robotized spray-up techniques. Those processes produce important emissions, mostly styrene. The permissible exposure value for styrene has been modified during the last revision of air contaminant rule (1994) in the province of Quebec, changing from 100 ppm to 50 ppm (time-weighted average).

These industries are at risk for the health and safety of workers because of all the products necessary to the fabrication of reinforced plastics. The exposure often exceeds the standard and the management of inflammable products must improve to ensure secure conditions of storage, handling, and use of these products.

A provincial program has been set up with the objective of reduction of exposure and control or elimination of principal dangers regarding health and safety in those work areas. This program targets about 170 establishments with activity in that field and producing all types of composite products such as transport equipments, boats, baths, showers, architectural pieces, tanks, excluding aeronautical equipment of high technology. The interventions are conducted by all CSST's inspectors and all the personnel (doctors, industrial hygienists, technicians, nurses) of the occupational health services in Quebec in order to convince this industry of the need to act, to support it in the choice and the setting of the necessary measures to implant in order to ensure safe working conditions and to use constraint to respect the regulation standards, if necessary (in case of refractory employers or immediately dangerous situations). The interventions are conducted by adequately trained personnel, sensitized to dangers and solutions, to identify and quantify the risk and to delimit the conditions not respecting safety. Some activities of formation and information to workers are planned. Concrete tools to help the employer in the search of solutions have been developed (technical guides and folders). The interventions are planned for the next 2 years and aim to improve conditions in those work environments with complex and divers risks.

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UTILIZING PROCESS HAZARDS MANAGEMENT TO DECREASE WORKER EXPOSURES WHILE INCREASING PRODUCTIVITY. R.P. Oliveti, Emilcott-dga, Inc., Westerville, OH

This report examines individual elements of a process hazards management program and how these elements can be utilized as both a tool for improving worker health conditions and also as a tool for productivity improvement.

For a process hazards management program to be successful, it must involve the direct interaction between chemists, engineers, plant management/supervision, plan operators, and maintenance personnel as well as health and safety professionals. This direct interaction is in contrast to the more historical practice of each group working independently. This presentation shows that the interaction among these various disciplines is not only successful in reducing health and safety hazards, it also tends to improve the productivity of the operation. These productivity improvements are quite often measurable and in many situations justify a process hazards management system as a tool to assist in cost containment. Individual elements detailed in this report that have been shown to have an effect on both employee health and productivity include, process hazard analysis, management of change, mechanical integrity, incident investigation, and contractor safety.

Process hazards management is a tool designed to reduce worker exposures by understanding a process in its entirety. This report details how that tool can be utilized for additional purposes, thereby making it a more attractive part of an overall management system. Though our main focus remains the health and safety of the worker, costs savings is a method of justifying implementation of this type of program when there is no regulatory requirement.

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PLANNING FOR BUILDING DISCHARGES INTO THE ATMOSPHERE. G. Miller, Lawrence Livermore National Laboratory, Livermore, CA

We have developed comprehensive guidance for designing atmospheric discharges from buildings, such as stacks. This paper describes the process we follow.

The process has these steps: (1) select acceptable exposure criteria for personnel located on and off-site in both normal and emergency conditions; (2) determine emission rates; (3) select emission controls based on estimates of emission rates; (4) if a tall stack is needed, then determine the minimum stack height to loft the effluent clear of the turbulent flows around the building or determine the available dilution if the effluent cannot be lofted out of the turbulence zones based on Halitsky's guidance referred to in Chapter 14 of the ASHRAE *Handbook of Fundamentals*.

The presentation will focus on using surrogates for the AIHA Emergency Response Planning Guidelines (ERPGs) when there is no ERPG or ERPG substitute, and if time permits, recent improvements in determining emission rates, the attributes of an ideal air cleaning device, when Halitsky's guidance is not applicable, and issues where further work is needed.

This updates a paper presented at the 1990 AIHCE. This paper will provide more details about how we plan for discharges from building into the atmosphere using modern tools and guidance.

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CLEANUP OF A BERYLLIUM-CONTAMINATED DOE FACILITY: EFFECTIVE EXPOSURE MONITORING AND EXPOSURE REDUCTION METHODS. M.S. Colalancia, H.J. Gordon, BNFL Inc., Englewood, CO

Two recently decontaminated production facilities that were previously used by the Department of Energy (DOE) for beryllium research, development, and manufacturing at the Rocky Flats Environmental Test Site, Colorado, were cleaned to greatly reduce beryllium contamination within them. Approximately 6000 surface wipes and 10,000 personal monitoring samples were collected as part of this project's Beryllium Health and Safety Program. Job safety assessments (JSA) coupled with work activity instructions defined and addressed all known and potential hazards associated with each decontamination and decommissioning activity facilitated reducing potential worker exposure to beryllium. The preparation of the JSA was completed as a partnership between project operations management, the Occupational hygiene department, team leaders, and team workers.

Using this approach, no employee received a beryllium dose greater than the established PEL. The project's action level for beryllium was one-tenth the PEL. Each exposure greater than the action level was evaluated to determine what activities were being performed and to make changes in work practices to prevent continuing exposures above this level without requiring additional engineering or administrative controls.

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A CONTROL STRATEGY MATRIX FOR THE AUTOBODY REPAIR INDUSTRY: SPRAY PAINTING AUTOBODY PARTS IN A DOWN DRAFT HOOD. J.M. Yacher, M. Wallace, W. Heltbrink, NIOSH Cincinnati, OH; T. Hoermann, BASF Corp., Whitehouse, OH

As part of product stewardship partnership for the autobody repair industry, an exposure control strategy for the autobody refinishing industry has been developed. The objective of this strategy is to keep worker exposure to polyisocyanates below 1 mg/m^3, which is the limit recommended by the paint manufacturers. This strategy recommends half-face piece respirators when automobiles are painted in a properly operated and maintained down draft spray painting booth. Prior work has shown that the use of these booths results in lower paint overspray exposures than other booths when spray painting whole vehicles. However, excess exposures still occur when painting individual autobody parts. Prior data collections indicated that painting parts suspended from the ceiling caused paint overspray to be dispersed throughout the booth and that an air purifying respirator was not likely to be sufficiently protective.

For parts painting off the car, a better approach is to place the part on a saw horse at waist height. This painting technique was simulated with the paint spray gun operated with compressed air only. Smoke tube traces indicated that the paint overspray would stay out of the worker's breathing zone. The jet from the spray painting gun moves air parallel to the floor until the jet's energy is dispersed. The air then moves toward the exhaust grates in the floor of the booth. Experimental work was done in a paint manufacturer's test and refinishing training facility to evaluate whether total paint overspray concentrations could be maintained below 10 mg/m^3 during autobody parts painting operations. The worker used an HVLP (high velocity, low pressure) spray gun with gravity feed to paint four autobody parts at a time, all positioned on sawhorses, in a down

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