Since the OSHAct was passed in 1970, employers have submitted time-weighted personal sampling results to demonstrate compliance with the Permissible Exposure Limits (PELs) for airborne chemicals. In 1977, NIOSH suggested area samples could be submitted for compliance if equivalence of measurement could be demonstrated. To date, area sampling results have not been submitted for this purpose, and equivalence of methods has not been demonstrated. Under workplace conditions, area sampling consistently underestimates personal exposure.

This study tested the hypothesis that under conditions required for the manufacture of semiconductors, the data from the real-time fixed-location mass spectrometer (a Perkin-Elmer ICAM) that monitors the process engineering controls could be time-weighted, and would be equivalent to the sub-ppm personal sampling results. In its on-line function, the ICAM can monitor a maximum of 25 chemicals, at each of 50 ports, once an hour. Six chemicals were chosen for study comparison: 2-Ethoxyethyl Acetate (Cellosolve Acetate), Diethylene Glycol Dimethyl Ether (Diglyme), n-Butyl Acetate (NBA), n-Methyl-2-Pyrrolidone (NMP), Propylene Glycol Monomethyl Ether Acetate (PGMMEA), and m-Xylene (Xylene). By increasing the ICAM dwell and cycle time to four minutes, from several milliseconds, the limits of detection (LOD) were comparable to those of the personal sampling. A total of 18,522 four-minute ICAM concentrations were coded by chemical, zone, shift, and port; the time-weighted mean concentrations were matched to 131 personal samples. Parametric and non-parametric statistics demonstrated that the paired mean concentrations using the two measurement methods were correlated.

For all six chemicals, the ICAM monitoring overestimated the personal sampling results; the methods of measurement were not equivalent when the concentrations were judged as TWAs. Because the concentrations were below the PELs for all six chemicals, time-weighted ICAM monitoring could be submi tted to demonstrate compliance . The sub-ppm LODs allow for monitoring of process engineering controls, and also provide a continuous record of the airborne chemical exposure of the employees. Where similar

255

BENZENE EXPOSURE TO WEIGHTS AND MEASURES INSPECTORS DURING GASOLINE PUMP CALIBRATION Brophy, M. O., New York State Department of Labor, Division of Safety and Health, 677 So. Salina Street, Syracuse, NY 13202, Roglieri, J., New York State Department of Labor, Division of Safety and Health, 30 Wall Street, Binghamton, NY 13901.

A Bureau of Weights and Measures exists in every county, as well as in many cities, in New York State. The mandate of the Bureaus of Weights and Measures is to assure accurate measuring in the practice of commerce. One of the measuring devices tested for accuracy by Weights and Measures inspectors is the gasoline pump. In the annual evaluation of every gasoline dispenser used in New York State these inspectors are exposed to gasoline fumes including benzene. Individual field surveys from Connecticut and California report benzene exposures in excess of the OSHA 8-hour time-weighted average (TWA) of lppm and in excess of the 15-minute short-term exposure limit (STEL) of 5ppm. This survey evaluates the exposure of inspectors from 10 counties in New York State to both aliphatic and aromatic hydrocarbons including benzene. Monitoring was performed by drawing a known volume of air through activated charcoal. The sample was desorbed with carbon disulfide and analyzed according to NIOSH method 1501. Monitoring was performed primarily during the testing of dispensing units at gasoline stations. Benzene exposure levels for inspectors in eight of the ten counties evaluated were less than lppm but greater than 0.1 ppm for an 8-hour TWA. Benzene was below detectable levels for the other two inspectors. Weights and Measures inspectors calibrate gasoline for less than a full 8-hour work shift and, therefore, it is important to assess the effect of the short term exposure to benzene on the health of the inspectors. Benzene short term exposure levels of up to 1.2ppm have been detected in this study. Although not required by OSHA at these exposure levels, a medical monitoring program could identify individuals that are manifesting early signs or symptoms of exposure when these effects are still reversible. Other factors that need to be addressed include work practices, administrative controls and atmospheric conditions. Because benzene can be absorbed through the skin, dermal exposure can contribute to the total body burden of benzene.

256

METHYL TERTIARY BUTYL ETHER -- ASSESSING EXPOSURES IN GASOLINE BLEEDING FACILITIES. R.A. Nocco and H.R. Coder, Chevron U.S.A. Products Company, Philadelphia Refinery, 3001 Penrose Avenue, Philadelphia, PA 19145. H.J. McDermott, B.L. Berard and K.L. Minter, Chevron Corporation, P.O. Box 7924, San Francisco, CA 94120.

The use of methyl tertiary butyl ether (MTBE), an oxygenated, high-octane gasoline bending component, has increased due to requirements of the Clean Air Act Amendments. The increased use of MTBE has caused many petroleum refiners to built facilities to transfer, store and blend MTBE into finished gasoline. Presently, there is no OSHA Permissible Exposure Limit or ACGIH Threshold Limit Value for MTBE . The AIHA's Workplace Environment Exposure Level (WEEL) guide recommends a limit of 100 ppm as an 8-hr Time Weighted Average (TWA). Chevron Corporation has adopted a more protective 50 ppm, 15-minute Short Term Exposure Limit (STEL) based on reports of irritation and discomfort from exposures above 100 ppm.

As a precaution when handling pure MTBE and until exposure profiles could be determined, operating procedures required workers to wear air purifying respirators. Several tasks associated with handling MTBE have been evaluated to determine worker exposure by collecting approximately 90, 15-min STEL samples. The exposures ranged from <0.03 to 220 ppm for routine tasks. Non-routine tasks such drum filling had exposures as high as 1040 ppm, 15-min STEL. Additionally, 20 full-shift, 8-hr TWA samples were collected which ranged from <0.06 to 5.4 ppm. Half facepiece, air purifying respirators can be used to protect workers during routine tasks such as gauging tanks, collecting samples, and connecting/disconnecting transfer hoses. Full facepiece, air purifying respirators are sufficient for the non-routine tasks monitored. Good work practices, which minimize the amount of pooling and spillage of MTBE, can reduce personnel exposures. For MTBE handling and gasoline blending facilities, the AIHA WEEL of 100 ppm is generally not exceeded .

257

CHARACTERIZATION OF SOURCE ACTIVITY AND EMISSION FACTORS FOR UNCONTROLLED TRICHLOROETHANE DEGREASERS S.A.Milz,R.A. Wadden, J.E. Franke, P.A. Scheff, and L.M. Conroy, University of Illinois at Chicago, Environmental and Occupational Health Sciences, M/C 922, PO Box 6998, Chicago, IL 60680

Hourly air samples for 1,1,1-trichloroethane (TCA) were collected on charcoal adsorption tubes over a two-day period during norrnal working conditions at 10 locations surrounding 3 open-top vapor degreasers at a semi-conductor plant. Continuous air monitoring was also conducted using 2 Foxboro/Wilks Miran IA General Purpose Gas Analyzers calibrated for TCA. In addition, degreaser activity was recorded for each minute during the sampling periods for each of the 3 lines. The hourly concentration data were used with the completely mixed space model ($V=2798\ m^3$ and an experimentally determined $k=0.3$) to estimate the overall emission rates from all 3 lines. These rates were compared with an experimental mass balance based on the measurement of air concentration and air flow at each exit and entry point.

The hourly results from these 2 approaches were highly correlated ($r^2=0.728$) with an average emission rate from the completely mixed space model of 6552 mg/min and an average emission rate from the experimental mass balance of 11718 mg/min. An inventory check based on the daily additions by maintenance personnel to the solvent reservoir resulted in an emission rate of approximately 10400 mg/min. The 1-minute Miran concentrations (420 observations) were then regressed against the activity observations from all 3 lines. The significant activities determined from this analysis were the times during which the degreasing tanks were uncovered (tank), the number of boards degreased during each cycle (part), the amount of time previously degreased boards remained near the sampling pumps (basket), and the board identification number (travel). A fit of the first day's hourly values using the fraction of time the tanks were uncovered indicated degreaser 2 and degreaser 3 contributed most of the emissions for used to model 10-minute emission rates based on Miran concentrations. This approach enabled us to determine short-term emissions from each line individually based on the activity data.

258

D-LIMONENE EMISSION FACTORS FROM A TERPENE ELECTRONICS PARTS DEGREASER C.B. Keil, J.E. Franke, R.A. Wadden, P.A. Scheff and L.M. Conroy, Environmental and Occupational Health Sciences (M/C 922), University of Illinois at Chicago, School of Public Health, Box 6998, Chicago, IL 60680-6998.

The phase-out of ozone depleting chloroflourocarbons (CFCs) called for in the Montreal protocol has led to a search for alternative compounds for use in various industrial processes. Terpenes are a potential replacement for CFCs in metal and electronics cleaning applications. Terpenes are a naturally occurring compound found in citrus oil. As a class of compounds terpenes have excellent solvency, rinsability, wetting, penetrating and detergent characteristics. They are considered to have low to moderate toxicity based on an incomplete but growing data base. Commercial formulations of terpenes have caused contact dermatitis and the odor is reported to produce a range of effects from headaches to nausea. Animal studies indicate that two of the terpenes, d-limonene and anethole are hepatotoxic to rodents. This study evaluated the emissions of d-limonene, the most abundant of the terpenes, around a conveyerized computer board degreaser. The degreaser was part of a prototype production facility in a 114,897 ft^3 room. The degreaser was originally designed for use with aqueous cleaners. A commercial cleaner (90% terpene, 10% anionic surfactant) was used in the unit on a trial basis. The degreaser consisted of an enclosed terpene spray wash side followed by an enclosed hot water spray rinse side with an air knife and drying oven at the exit end of the conveyor. The degreaser was equipped with local exhaust ventilation (LEV) on both enclosed spray sides and included a canopy hood over the open conveyor section between the two sides. Sulfur hexaflouride (SF_6) tracer gas studies were done to determine the effective air flow through the room. The effective airflow through the room was 10,946 cubic feet per minute or 5.7 air changes per hour. Air samples were collected at eight locations around the room including LEV ductwork. A short term sample was collected prior to the start of degreasing operations. This background d-limonene concentration was 0.03 mg/m^3. The average room concentration during degreaser operation was 0.53 mg/m^3. The LEV-captured d-limonene emissions were calculated using duct concentrations and duct flowrate. The average captured emission rate was 11,263 mg/min. These emissions were found to be strongly correlated with board throughput and can be described as mg emitted = 2,181 x number of boards degreased + 10,204 ($r^2 = 0.96$). Board throughput varied from 0 to 57 boards per hour with an average of 29 boards per hour.

Papers 259–264 Electromagnetic Fields: What Should We Be Telling Our Workers?

259

THE DETERMINATION AND EVALUATION OF ELECTRO-MAGNETIC FIELDS Alfred F.Steinegger, Health and Safety Consultant, CH 3973- Venthône, Switzerland.

The question of health effects due to the exposure to electromagnetic fields is becoming increasingly the subject of discussion in recent times. There are still many questions open concerning the biological and harmful effects of magnetic fields. Nevertheless it is important to dispose of exposure measurements for instance as a basis for future studies. A possible procedure in different steps for the determination of magnetic fields at the workplace is shown by an example of the primary aluminium industry. High direct currents of for instance 140 000 A are used in producing aluminium by the electrolytic process. As a first step, a rough estimation results a magnetic induction of max.300 G (30 mT) in a distance of 1 meter to the main current conductor. By a sophisticated calculation values of 25 - 100 G (2. 5 - 10 mT) at different locations of the typical working area were derived. In a further step these calculations have been confirmed by stationary measurements at the same places about 1 m above the ground level. At some "hot spots" where the operator stays only occasionally, the values were between 100 - 200 G (10 - 20 mT). We can estimate that the exposure for routine work is less than 100 G (10 mT) which is well below the TLV (ACGIH) of 600 G (60 mT). Personal dosimeters would permit a better evaluation of the exposure at these workplaces. Personal monitoring was made with a prototype probe analyzer, built according to the indications by the Aluminiumindustriens Miljøskretariat/University of Oslo. In combination with a data logger it was possible to get data for a better evaluation of the exposure by dosimetry. Preliminary short measurements for a few hours have given values in the range of 30 - 80 G (3 - 8 mT). These values have to be confirmed by a more extended measuring campaign, including values of the dosimetry for single workers over an eight hours shift.

260

CHARACTERIZATION OF OCCUPATIONAL EXPOSURE TO EXTREMELY LOW FREQUENCY MAGNETIC FIELDS IN A HOSPITAL. K. Philips, M. Morandi, University of Texas School of Public Health, P.O. Box 20186, Houston, TX 77225; D. Oehme, P. Clouthier, Innovatum, Inc., 2020 SW Freeway, Suite 203, Houston, TX 77098.

Research on electromagnetic field (EMF) parameters which may be associated with observed bioeffects has produced a complex pattern of relevant exposure parameters, including threshold, window, peak or cumulative values for field intensity and frequency, as well as waveform and geomagnetic orientation. A characterization study of exposures to extremely low frequency magnetic fields (ELF; 40-1000 Hz) as determined by these parameters was undertaken in technical areas of a large research hospital.

Exposure data were obtained through a combination of work/time analysis, specific site surveys, personal EMF dosimeters, and a magnetometer. A wide variation in exposures was observed. For example, computerized tomography technicians' exposures were found to vary in both intensity and spectral frequency distribution depending on the workers' location relative to a specific EMF source. In one station the worker experienced ELFs as high as 38 mG (3.9mG-hr), with 6.1 excursions/hour over 10mG, and 20% of his EMF exposure at 60 Hz, 17% at 180 Hz, 8% at 360 Hz, and 4 . 9% at 895 Hz . In another station with the same equipment, but different technician traffic pattern, the maximum intensity was 9 . 9mG (1 . 76mG-hr), with no excursions over 10 mG, and a exposure frequency distribution of 59% at 60 Hz, 9% at 180 Hz and 5.1% at 895 Hz.

The results indicate that signif icant ELF exposures can occur in hospitals. The intensity and spectral characteristics of the exposure vary both within and between job categories, and depend on the specific sources and activity patterns. These exposures could be significantly reduced by changing location of identified sources and/or worker's traffic patterns . This approach to ELF exposure characterization is applicable to other occupational settings.

261

ELECTROMAGNETIC SURVEY OF EMPLOYEES EXPOSED TO NON-DESTRUCTIVE TESTING (NDT) OF DRILLING PIPE J.D. PAZ, L. WALKER, J&L Inc., P.O. Box 33036, Las Vegas, NV 89133, R.K. Stanley Baker, Hughes Tubular Services, Inc. 9400 Bamboo Rd., Houston, TX 77270-7631 and J. Mackin, IPIA International Pipe Inspector Association, 4101 Oates Rd., Houston, TX 77013, and E. Moss, NIOSH, 4676 Columbia Parkway, Cincinnati, OH 45226.

An Electromagnetic (EM) survey of employees testing the integrity of pipe test fitting was performed. Because of concern about the potential health effects of employee exposures to high EM fields. It is estimated that over 100,000 or more employees are exposed to various high EM levels. Literature reviews indicated that the EM field strength generated during NGT is varied and ranges from 100 to 300 Gauss (G), depending upon pipe size and customer specifications. The literature surveys indicate that EM is not a hazardous concern, and were not even considered as a potential health hazard by the American Society of Non-Destructive Testing in their 1989 handbook.

EM measurements were taken with an ELF Walker Industry Monitor, Model MG-D4. The magnetic field was generated by a mobile unit, operated at 110 Volts and 60 Hz.

The following static EM field strengthes were monitored at magnetic coil levels taken 1 meter from magnet; ranges from 2.7 to 119 G were measured. EM measurements in the position of the operator's body taken during NDT testing procedures tkaen about 30 cm from coil were: Head 3.0 G; Chest 6.2 G; Gonads 3.0 G; Arm 4.0 G; Shoulder 1.4 G; and, 7.2 G at 1 meter from the source. During the survey it was also noted that the magnetic coil was left in the on position; employees were often observed to neglect closing the switch, consequently continuing to expose themselves to continuous high EM field strengthes. This most likely exceeded the new ANSI standard and ACGIH guidelines.

These high values of EM measurements raise serious questions about potential health effects to employees exposed to high levels of the EM fields measured. We are recommending that comprehensive EM dosimetric surveys, training of employees and steps be taken to reduce worker exposures to high EM fields.

262

COMPARISON OF EXTREMELY LOW FREQUENCY MAGNETIC FLUX DENSITY EXPOSURES OF ELECTRICAL AND NON-ELECTRICAL WORKERS AT THE LOS ALAMOS NATIONAL LABORATORY J.N. Hollander, The Los Alamos National Laboratory, P.O. Box 1663, MS K494, Los Alamos, New Mexico 87545; P.N. Breysse, The Johns Hopkins University School of Hygiene and Public Health, 615 North Wolfe Street, Baltimore, Maryland 21205.

In epidemiologic studies of occupational cohorts exposed to extremely low frequency (ELF) electric and magnetic fields, the absence of field measurement data forced investigators to use surrogates of exposure, such as job titles. Although the presumption of exposure associated with job titles may be generally defensible it is not possible to determine what ELF field parameters are associated with the excess risk suggested by some of these studies. The purpose of this study was to evaluate worker exposure to ELF magnetic fields in jobs which could be readily classified as electrical or as working around large amounts of electricity and to compare these exposures to a sample of non-electrical workers.

Job classification as electrical or non-electrical was based on the Los Alamos National Laboratory Health Hazard Assessment (HHA) Operation Codes. 20 different electrical workers and 20 comparison workers were included in this study. Full and partial-shift exposures to power frequency (60 Hertz and harmonics) magnetic fields were measured. Each worker was measured on at least three

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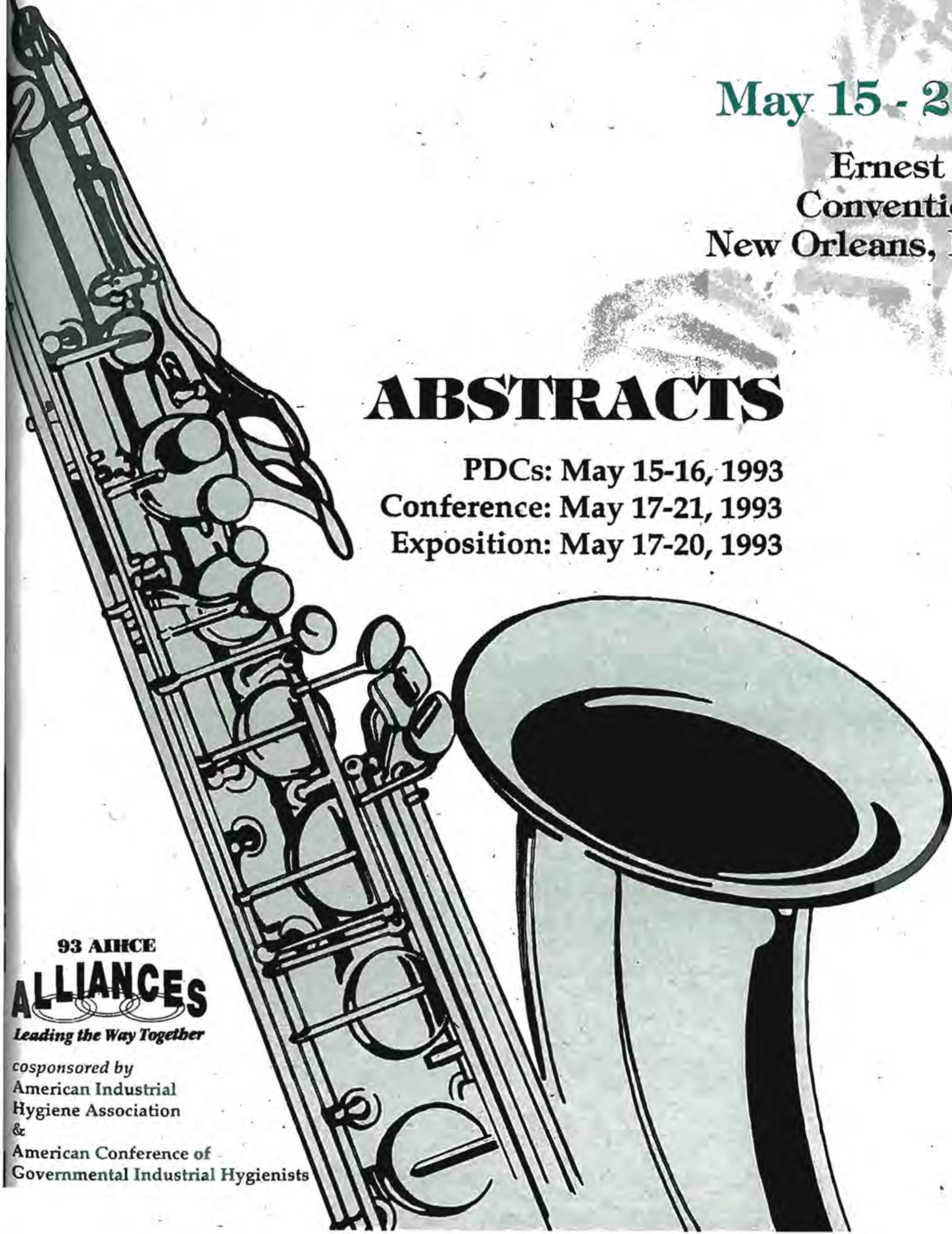

ABSTRACTS

PDCs: May 15-16, 1993
Conference: May 17-21, 1993
Exposition: May 17-20, 1993

93 AIHCE
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2000901