work and 10.0% off-work, whereas their exposure exceeded 10 mG in 6.8% of the time spent at work and 1.5% off-work. Exposure of office workers exceeded 2 mG in 33.7% of the time spent at work and 7.7% off-work, whereas their exposure exceeded 10 mG in 0.2% of the time spent at work and 1.6% off-work. In conclusion, while there was no significant difference between occupational and nonoccupational exposure in office workers, electricians' occupational exposure to magnetic fields was significantly higher than their own nonoccupational exposure and that of office workers.

## 18

COMMUNICATING RISKS OF ELECTROMAGNETIC FIELDS: THE EFFECTS OF HIGH AND LOW THREAT RISK MESSAGES ON ATTITUDES AND BEHAVIOR. S. McMahan, University of California Irvine, CA; J. Meyer, Rutgers University, Camden, NJ

Communicating the risks of exposure to extremely low frequency electromagnetic fields has been a topic surrounded with much controversy. There are very few guidelines in the industrial hygiene literature with regard to explaining the hazards of an unknown risk with high outrage potential. The purpose of this study was to explore the effects of high and low threat risk messages on attitudes and behavior. High and low threat risk messages were administered to 251 college undergraduates. Subjects were randomly assigned to read either a high or low threat EMF risk message and then answer questions pertaining to their attitudes and opinions regarding EMFs. A follow-up questionnaire was assessed two weeks later addressing the initial attitudinal questions and control measures implemented to reduce exposure to EMFs. One hundred fifteen subjects read the low threat risk message and 136 read the high threat risk message. There was a significant difference between low and high threat subjects on 1) whether EMFs frighten and scare subjects; 2) whether health effects related to exposure are severe, significant, and serious; and 3) whether reducing exposure is effective in preventing unwanted health effects such as cancer (effect seen only at time two). Multiple regression analysis indicated that the type of risk message, response efficacy and behavioral intentions were the strongest predictors of reducing ones' exposure. This research study demonstrates that the type of EMF risk message presented may have an effect on attitudes, intentions and behavior change among readers. In providing a list of control measures individuals had control over their exposure to EMFs. The limitations of this study pertain to the demographics of the study population (college educated) and may limit the generalizability of the findings.

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## 19

THE DETERMINATION OF THE QUALITY OF PROFESSIONAL JUDGEMENT IN EXPOSURE RECONSTRUCTION. T. Hall, N. Esmen, University of Oklahoma, HSC, Oklahoma City, OK

In many occupational epidemiologic studies, in the absence of quantitative data, a delphic method based on professional judgment has been used for exposure reconstruction. Typically, workers, managers and/or industrial hygienists use their knowledge of processes to assign the exposures to sub-groups of a cohort. While much credence has been given to the quantitative results of this type of processes; irrespective of the numerical manipulations used, a delphic method is necessarily qualitative. Since the consistency of the multiple individual judgments to rank exposures affect the credibility of the results, a method to quantify the judgmental consistency from an individual or group perspective is essential. The method described here uses a 1 to 1 comparison technique of ranking to define individual and group consistencies. The theoretical justification of the procedures are similar to the analytic hierarchy process used in multi-criteria decision analysis. The trial application of the method for verification purposes uncovered several significant problems with 'professional judgment' reconstruction of exposures. For example, if one or more assessors are inconsistent their exclusion will increase the group consistency but will not necessarily provide for a more accurate exposure assignment. If an assessor group is shown to be inconsistent or biased, then the credible results can be achieved only if there is another set o f consistent and unbiased experts are available. The analysis of the results that can be provided by the propose d method suggest that the results of any expert opinion based delphic analysis must be scrutinized extensively before they can be accepted in an occupational epidemiologic study as credible conjectures that mirror the exposures.

## 20

AIRCRAFT CABIN EXPOSURES OF FLIGHT ATTENDANTS: A FEASIBILITY STUDY. M. Waters, T. Bloom, D. Booher, B. Grajewski, NIOSH, Cincinnati, OH; S. McFarland, University of Texas, Houston, TX

Studies suggest that female air crew members may experience an increased risk of miscarriage and other adverse reproductive outcomes. Exposures that may contribute to adverse reproductive outcomes include cosmic radiation and cabin environmental quality factors such as ozone, environmental tobacco smoke, and hypobaric pressure. However, cabin exposure data are sparse. As part of a NIOSH-FAA epidemiologic study of reproductive health in female flight attendants, an exposure assessment feasibility study was conducted on commercial aircraft. The primary objectives of the feasibility study were to evaluate and refine exposure monitoring procedures for cosmic radiation and cabin air quality, identify flight factors influencing air quality, evaluate instrument functioning during flight, and determine feasibility of a larger study. In addition to meeting these objectives, cosmic radiation dose and indoor air quality data were successfully collected on the eight short- and medium-duration flight segments. Cabin air quality and physical parameters monitored included volatile organic compounds, nitrogen oxides, carbon monoxide, carbon dioxide, ozone, temperature, relative humidity, and barometric pressure. Monitoring was conducted in the front third and rear third of the coach compartment on five different aircraft models. One-minute average concentration ranges were: carbon dioxide 540-2879 ppm; ozone <0.01-0.47 ppm; carbon monoxide <1.-4.4 ppm; nitrogen oxides <0.3-0.7 ppm; and total particulates <0.02-0.04 mg/m$^3$. Carbon dioxide exposures were highest during periods of passenger activity and varied among different aircraft models. Cosmic radiation dose ranged from 5-29.3 µSv per flight. Based on this study, it is concluded that a full-scale exposure assessment on commercial aircraft to support concurrent epidemiologic studies is feasible, and a large scale study is planned.

## 21

CHARACTERIZATION OF HYDROGEN SULFIDE AND ENDOTOXIN EXPOSURE AT THREE WASTEWATER SEWAGE TREATMENT PLANTS. D. Marlow, NIOSH, Cincinnati, OH

Investigators for the National Institute for Occupational Safety and Health (NIOSH) conducted health hazard evaluations (HHEs) at three municipal wastewater sewage treatment plants. These evaluations were conducted in response to reported worker health symptoms including periodic headaches, burning sensation in the nose, shortness of breath, sore throat, eye irritation, nausea, and diarrhea. Personal breathing zone (PBZ) and area air samples were collected for hydrogen sulfide using passive monitors with electrochemical sensors and data loggers. Personal breathing and area air samples also were collected for endotoxin using tared, 5.0-micrometer pore size, 37-millimeter diameter, polyvinyl chloride filters operated at a volumetric airflow rate of 1.5 liter per minute. Each filter sample was extracted with sterile, nonpyrogenic water with supernates being analyzed for endotoxin by quantitative chromogenic Limulus amebocyte lysate test.

Maximum PBZ hydrogen sulfide concentrations ranged from nondetectable (ND) to 124 parts per million air (ppm). Ten of 21 PBZ sample results for hydrogen sulfide exceeded the NIOSH recommended exposure limit (REL) (the NIOSH REL for hydrogen sulfide is a ceiling concentration of 10 ppm, which must not be exceeded during any part of the workday), and 7 of the 21 samples exceeded the OSHA permissible exposure limit (PEL) (the Occupational Safety and Health Administration [OSHA] PEL for hydrogen sulfide is a ceiling limit of 20 ppm). The high-

est exposures to hydrogen sulfide occurred while working in sludge dewatering and incineration operations. The 124 ppm hydrogen sulfide concentration, which exceeds the immediately dangerous to life or health concentration of 100 ppm, was measured on a maintenance worker performing repairs in the sludge dewatering operations. Time-weighted average personal breathing zone concentrations for endotoxin ranged from ND to 10.9 endotoxin units per cubic meter of air (EU/$m^3$). No REL or PEL has been established for endotoxin. Rylander suggested a maximum exposure limit of 100 EU/$m^3$. These levels were well below this suggested exposure limit.

Based on the overexposures to hydrogen sulfide, recommendations made included the use of personal monitors for hydrogen sulfide for those workers with exposure that exceeded 5 ppm, and the use of the appropriate respirator when hydrogen sulfide concentrations exceeded 10 ppm.

## 22

EXPOSURE ASSESSMENT OF MAINTENANCE RELATED WELDING AND THERMAL CUTTING IN THE ELECTRIC AND GAS UTILITY INDUSTRY. A . Siert, Public Service Company of Colorado, Denver, CO; H. Beaulieu, Industrial Hygiene Resources, Boise, ID

Utility maintenance and construction welders' exposures are particularly difficult to characterize due to the nonrepetitive nature of the job tasks performed. This situation had resulted in the majority of welding and cutting jobs in this industry being conducted in the absence of industrial hygiene controls.

Electric and gas utility welders are exposed to a wide spectrum of fumes and gases generated by the various welding and cutting processes. This assessment was directed at a comprehensive process/job task analysis in conjunction with exposure assessment to better characterize and predict exposures in this industrial trade. The process/job task analysis was conducted for welding and cutting at nine power plants, and production and fabrication shops, gas pipeline services, transportation maintenance, and construction division. Variables characterized included facility, job tasks, locations, base metals, consumable composition, shielding gases, duration, and engineering controls. Relative job task percent as a fraction of all work was also estimated.

The exposure assessment was conducted over a 114-day sampling period, in which more than 1,338 personal breathing zone samples were collected and analyzed for in-house and contractor welders. Welders were asked for a given job task to estimate the perceived fume levels and duration as compared to "typical" for that job task. Percent "arc on, or torch on time" for welding and cutting was also estimated. Welders were periodically exposed to individual air contaminant concentrations in excess of OSHA ALs/PELs, or ACGIH TLVs for a variety of metal oxide air contaminants, including cadmium, copper, lead, arsenic, beryllium, manganese, zinc chromate, chromium, zinc, iron and total fumes. Results, although not entirely predictable, have revealed patterns which will allow for better prediction of overexposures and appropriate selection of industrial hygiene controls.

## 23

HEALTH EFFECTS OF LONG-TERM STANDING ON THE FEMALE REPRODUCTIVE SYSTEM. P. Meng, S. Yu, Z. Cai, X. Gao, S. Yu, Shangdong Medical University Jinan, Shandong, Taiwan

Most of sellers in China were women. They stand to work all day. This is a cross-sectional study for the effect status of standing on female reproductive function. The study involved 491 saleswomen and 187 administrative female controls. They were all married and worked 6 hours per day. The two groups women were inquired about medical history, menstruation state, reproduction, etc. The results showed that the incidence of irregular menstrual cycle in saleswoman group was significantly higher than that in the controls (11.83%, 6.42%). The incidence of irregular menstrual period was 10.91% in saleswomen and 3.74% in the controls. The incidence of profuse or scanty of menstruation was 22.51% in saleswomen and 9.09% in the controls. The incidence of dysmenorrhea in saleswoman group was obviously higher (33.87%) than that in the control group (19.79%). There were no linear correlations between the length of service and the above-mentioned incidences of abnormal menstruations. Although the percentage of natural abortion, operational delivery, premature delivery and stillbirth were high, and the percentage of breast feeding and birth weight were low in saleswoman group, yet no significant differences were found. It is concluded that pathological change of menstruation function is a major result, which can be avoided by increasing some suitable work break and shortening the work time.

## 24

*Paper Withdrawn by Author*

# Biosafety and Biotechnology Papers 25–30

## 25

AGENT-BASED RISK ASSESSMENT OF INFECTIOUS AGENTS USED IN BIOTECHNOLOGY: BIOLOGICAL SAFETY DATA SHEETS. D. Fleming, Bowie, MD

Safety in Biotechnology requires control of potential hazards, including infectious agents. Before such agents are used, they should be assessed for risk of workplace and community infection and disease. For an agent-based risk assessment, information is needed regarding pathogenicity, host range, infectious dose, virulence, stability, method and route of transmission, communicability, severity of disease and availability of treatment or prophylaxis. Specific information is also needed regarding strain variations, agent or vector endemicity, and resistance to drugs of choice in the treatment of the disease. No single source provides the information needed. Case reports, review articles, medical microbiology textbooks and manuals published by professional organizations are useful. Agent summary statements found in federal guidelines cover agents that have caused laboratory-acquired infections. Similar information is needed for agents used in the production of drugs or biologics. The Material Safety Data Sheets-Infectious Agents compiled in Canada are agent-based. Using a similar format, Biological Safety Data Sheets (BSDS) were prepared for some organisms used in biotechnology in the United States: Mycobacterium tuberculosis, Neisseria meningitidis, Saccharomyces cerevisiae and the Hepatitis A and B viruses. Each BSDS is agent-based; it does not apply to intermediates following disinfection, other downstream processing which inactivates the agent, or to the final product. The BSDS is used in conjunction with information on specific strain, work practices, operating procedures, equipment, processes and facility design to determine the containment conditions required for control of that biohazardous agent in the workplace. Biological Safety Data Sheets can expedite access to the information needed to provide Safety in Biotechnology.

## 26

ASSURING THE HEALTH OF THE BIOTECH WORKFORCE. J. Van Houten, Johnson & Johnson, Raritan, NJ

Throughout the biotechnology industry, bacteria, viruses and mammalian cells are used either as "factories" for the synthesis of products or as the products themselves (e.g., vaccines). During the discovery process, biological agents can be handled safely in the laboratory using guidelines described in the CDC-NIH publication Biosafety in Microbiological and Biomedical Laboratories. Depending on the risk group of the agent, facilities and work practices are prescribed in accordance with Biosafety Levels 1-4. As development continues and scale-up proceeds, increasing volumes of biological agents must be handled, posing a risk to the health of employees. Appropriate controls include the use of large-scale containment guidelines. For organisms containing recombinant DNA, the best guidance is found in Appendix K of the NIH Guidelines for Research Involving Recombinant DNA Molecules. This document describes four levels of large-scale containment—Good Large Scale Practice through Biosafety Level 3-Large Scale. When the organism is nonrecombinant, the guidelines are less clear. However, the principles outlined in the NIH guidelines still apply since the risk is primarily associated with the pathogenicity of the host organism. A standard is currently in preparation by a committee of the American Society for Microbiology to provide for containment of nonrecombinant pathogens. These strategies, coupled with a consideration of the other safety and industrial hygiene hazards associated with the process, will help assure the health of the biotechnology workforce.

# 1997
# American Industrial Hygiene Conference & Exposition

AIHCE '97
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# Abstracts

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### 1

*Paper Withdrawn by Author*

### 2

PRAGMATIC PRINCIPLES FOR AVOIDING MANAGEMENT PITFALLS. M.L. Sanders, Naval Engineering Field Activity, Poulsbo, WA

Making the transition from an industrial hygienist managing programs to a manager programming industrial hygienists can be traumatic and career damaging. Keen technical and verbal skills are common entrance requirements to the people-management arena, but industrial hygienists who desire to make that professional move must be aware of three particularly dangerous pitfalls which neither of those skills will protect against.

One pitfall results from failure to distinguish between leadership and management, another from failing to distinguish between organizational process and function, and the third for failing to recognize the customer. Industrial hygienists must have the insight to recognize and evaluate those pitfalls, avoiding or backfilling in order to walk safely over them.

Specific and succinct descriptions of principles for both the prevention and the resolution of these problem areas have been developed; use of these principles is the catalyst for efficacious management. Whether the professional industrial hygienist is in the private or the public sector, assuming the responsibility for a controlled management response using these principles in the face of business adversity can turn impending failure into resounding success and ensure career growth.

### 3

SCIENTIFIC CONTRIBUTIONS TO THE REVISION OF THE OSHA'S 1,3-BUTADIENE HEALTH STANDARDS. C.T. Chen, OSHA, Washington, DC

The current OSHA's 1,3-butadiene (BD) health standard is an 8-hour time-weighted average (TWA) exposure of 1,000 ppm for workers exposure to BD which is adopted from 1968 American Conference of Governmental Industrial Hygienist's (ACGIH's) threshold limit values (TLVs®) in 1971 to prevent irritation and narcosis effects. Due to the demonstration that BD causes multiple cancers in two animal studies in 1983, OSHA was petitioned by unions in 1984 and referred by EPA in 1985 for regulatory action. In 1990, OSHA published a proposed BD standard with an 8-hour TWA exposure of 2 ppm, a short-term exposure limit (STEL) of 10 ppm, and the ancillary provisions. There are many scientific studies contained in OSHA BD docket which enhanced the completion of a BD standard. Animal bioassays, human epidemiologic studies, experimental investigations on the metabolites and their mechanism in vitro and in vivo systems provides convincing evidence that BD is a probable human carcinogen. Three out of five quantitative risk assessments used NTP study with exposures of 6.25–625 ppm BD to calculate their best estimates of risk. Due to the availability of three breakthrough studies on BD, OSHA was able to allow the use of cartridges and canisters for respiratory protection that would enhance workers' protection, address industry's concerns, and reduce compliance cost. A series of plant visits conducted by the National Institute of Occupational Safety and Health (NIOSH) produced worker exposure profiles and information on technological feasibility which greatly helped in economic analysis. An epidemiologic study sponsored by the International Institute of Synthetic Rubber Producers (IISRP) completed in late 1995 clearly demonstrated an excess risk of cancer among workers exposed to BD which is complementary to the animal studies. This promoted IISRP to engage with unions to reach agreement on a standard with an 8-hour TWA exposure of 1 ppm, a STEL of 5 ppm, and other aspects of standard. This demonstrates that studies from various disciplines of science will greatly enhance the development of a workplace health standard. The opinion expressed here is sole of author.

### 4

CIH PLUS IHIT UTILIZATION BY INDUSTRY OR INDUSTRY GROUP, AND PRELIMINARY PROJECTIONS OF FUTURE NEED FOR SUCH INDUSTRIAL HYGIENE PROFESSIONALS. L.W. Whitehead, CIH University of Texas-Houston Houston, TX, M. West Baylor College of Medicine, Houston, TX

Estimates of future need for public health professionals are very useful for planning educational programs and incentives for graduate education, and for staffing projections. No such estimates are known to exist for