assessment is used to estimate the likelihood and severity of an oxygen deficiency event. Together, the liklihood and severity determine the required level of engineering and operational control as well as personal protective equipment. The hazard assessment methodology, with emphasis on determination of the source terms, is presented. Source terms for input into the risk function come from a systems analysis such as fault tree, release rates from chemical process safety applications, and oxygen deficiency estimates from a two compartment ventilation model adjusted for the characteristic behavior of liquid helium releases. A risk function termed the oxygen deficiency hazard rate (ODH), which has been in use in other accelerators, combines time to incapacitation at a given oxygen level with a system failure rate. The ODH rate triggers an ODH categorization of 0 to 4, with 4 requiring the most stringent control.

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ASSESSMENT OF STATE AIR TOXICS REGULATIONS: A CASE STUDY. C. Feigley, H. Pastides, C. Prince, University of South Carolina, Columbia, SC; D. Jollow, Medical University of South Carolina, Columbia, SC.

A Workgroup was formed to recommend science-based methods for determining which air pollutants should be regulated under South Carolina Air Toxics standard (Regulation 62.5, Standard 8) and for specifying appropriate ambient concentration limits (ACLs) for protecting public health. These methods were to make efficient use of existing data sources and guideline levels, recognizing that State agency resources are limited. Initially, state air toxics regulations, policies, and approaches throughout the United States were surveyed and analyzed. States with their own air toxics regulations were found to have higher population, a greater portion of the population less than 5 years old, higher gross state product, higher per capita income, higher ambient concentrations of air toxics; they were more likely to have fishing and tourism as important industries. The Workgroup concluded that the SC Standard is essential for controlling air toxics for protection of public health because it complements federal standards. Recommendations included listing/delisting criteria based on weight-of-evidence cancer classifications and noncancer exposure limits developed by national and international organizations, and a tiered protocol for setting ACLs based on carefully developed exposure guideline levels. The Workgroup observed that developing ACLs to control cancer risk requires that the State specify an acceptable risk level. Also, although ACLs may be set to protect people within the normal range of susceptibility, ACLs protecting hypersusceptible persons now are not scientifically feasible.

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OCCUPATIONAL EXPOSURE LIMITS FOR FREONS IN POLAND. K. Konieczko, The Nofer Institute of Occupational Medicine, £6dŸ, Poland; S. Czerczak, The Nofer Institute of Occupational Medicine, £6dŸ, Poland.

Cardiotoxicity is thought to be the most essential effect of exposure to trichlorofluromethane (CFC-11), dichlorodifluoromethane (CFC-12), and 1,2-dichloro-1,1,2,2-tetrafluoromethane (CFC-114). In a study involving ten volunteers exposed by inhalation to freon 11, freon 12, freon 114, no clear-cut pathological changes in ECG were found, although most subjects developed heart rate variability exceeding that noted before exposure. In a few cases T wave inversion, and in one case atrioventricular block, were observed. The time of exposure was 15, 45 or 60 seconds. The concentration of propellants in the air ranged from 16 to 150 g/m3.

In exposure to chlorodifluoromethane (CFC-22), the major effect of the short-term exposure is cardiotoxicity (NOAEL - 87.5 g/m3). In a long-term experimental study, systemic toxicity was observed. The rats exhibited a statistically significant increase in the kidney, adrenal and pituitary weights. NOAEL of 35,400 mg/m3 for systemic effects was determined.

Dichlorofluoromethane (CFC-21) produces mainly hepatotoxic effect. The Polish proposal of occupational exposure limit was based on a 90-day animal study. NOAEL of 213.8 mg/m3 for hepatotoxicity was established.

Dibromodifluromethane (freon 12B2) is an irritant, hepatotoxic and neurotoxic agent. The no-effect level of 3,000 mg/m3 in animals exposed for up to 7 months was determined.

Based on literature data, the occupational exposure limits for freons in Poland were proposed.

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TOXICOLOGY, RISK ASSESSMENT AND THE INDUSTRIAL HYGIENIST. G. Briggs, Geo Centers, Inc., Naval Health Research Center Detachment (Toxicology), Wright-Patterson AFB, OH; K. Still, Naval Health Research Center Detachment (Toxicology), Wright-Patterson AFB, OH.

Risk assessment is an interdisciplinary method of quantifying health risks associated with exposure to environmental and occupational toxicants. Industrial hygienists, toxicologists and epidemiologists provide most of the vital information used in risk assessments of chemicals of interest to the U.S. Navy. These data are used to characterize the toxicology of potential hazards, perform human health hazard evaluations, and to formulate appropriate exposure limits for Navy operations. The roles of industrial hygienists and risk assessors will be discussed and evaluated for developing critical data for hazard identification, dose response evaluation, exposure assessment and risk characterization. This information is vital to effective risk management decision making. Examples of how our interdisciplinary team works together within the Navy to perform risk assessments are presented. The integration of processes used by toxicologists and industrial hygienists in establishing appropriate risk management policies to help ensure readiness of sailors in completing the military mission will be discussed. The presentation will focus on problem solving, determining the nature and magnitude of the problem, and determining what decisions are needed to prevent health risks and, in establishing the criteria for ensuring that readiness of sailors is maintained.

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EVALUATION OF REPRODUCTIVE TOXICITY FROM EXPOSURE OF MALE RATS TO JET PROPULSION FUEL JP-8 VAPOR. W. Price, G. Briggs, Geo Centers, Inc., Naval Health Research Center Detachment (Toxicology), Wright-Patterson AFB, OH; K. Still, Naval Health Research Center Detachment (Toxicology), Wright-Patterson AFB, OH; K. Grasman, Wright State University, Fairborn, OH.

Each year several hundreds of thousands of U.S. Air Force, U.S. Army, and U.S. Navy & Marines personnel are exposed acutely or chronically to JP-8 vapor. Although the U.S. Navy & Marines have traditionally used JP-5 fuel for powering of aircraft and land vehicles, there is an ongoing transition to predominant use of JP-8. These exposures occur directly during workplace and combat deployment, but often occur indirectly to personnel simply assigned near fuel-handling sites. Typically, these exposures occur with no respiratory protection. While there is substantial evidence that acute or chronic exposure to other jet fuel vapor or aerosol may induce significant deficits in humans, there has been little relevant published research on the effects of acute or repeated exposure to JP-8 vapor. The Hamilton Thorne sperm analyzer was used to evaluate sperm damage produced by inhalation exposure to JP-8 in laboratory rats. Groups of male rats were exposed to room air or to jet fuel vapor at 1000 mg/m3, 500 mg/m3 or 250 mg/m3 for 6 hours per day, 7 days a week for 90 consecutive days to determine if exposure resulted in damage to the reproductive system. The inhalation exposure system consisted of a vapor generator, a 670 L whole body inhalation air control exposure chamber, three exposure chambers identical to the control chamber and an IR-vapor concentration analyzer. The vapor exposure chambers were filled with JP-8 vapor on a continuous basis and the control chamber was filled with HEPA filtered room air at a rate of 72 L/min. After exposure, rat semen was analyzed using the Hamilton Thorne sperm analyzer computer assisted semen analysis (CASA) for sperm count, concentration, motility and morphology. Sperm quality parameters were evaluated (sperm concentration, motility, and morphology) to provide evidence of sperm damage.

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GLUTARALDEHYDE: A NEW STRATEGY FOR UPDATING RECOMMENDED EXPOSURE LIMITS. K. MacMahon, J. Wess, C. Forrester, M. Haring Sweeney, NIOSH, Cincinnati, OH.

The Occupational Safety and Health Act of 1970 authorizes the National Institute for Occupational Safety and Health (NIOSH) to develop criteria, including recommended exposure limits (RELs), for preventing disease and hazardous conditions in the workplace. A REL is an occupational exposure limit recommended by NIOSH as being protective of worker health and safety over a working lifetime. NIOSH determined that an updated REL was indicated for glutaraldehyde as significant adverse health effects including contact dermatitis and asthma have been reported to occur in workers exposed below the current glutaraldehyde REL of 0.2 ppm (0.8 mg/m3) as a ceiling limit. A new process has been implemented in the development of an updated REL for glutaraldehyde in which NIOSH's comprehensive toxicology and epidemiology literature evaluation is based on recent reviews published by other standard-setting groups. The Health and Safety Executive of the United Kingdom and the Nordic Expert Group in conjunction with the Dutch Expert Committee for Occupational Standards summarized the available occupational health literature on glutaraldehyde in 1997 and 1995, respectively. NIOSH has used these documents as the basis for its criteria document on glutaraldehyde. NIOSH has also reviewed the literature available since 1997 and evaluated current exposure data in order to develop a new REL and criteria

document for glutaraldehyde. In addition to a REL, a criteria document contains recommendations for minimizing safety and health risks including medical monitoring, exposure assessment, worker training, control technology, personal protective equipment, and recordkeeping.

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CAN FUNGAL INFESTED CARPET BE SAVED? P. Ellringer, S. Hendrickson, Tamarack Environmental Inc., St. Paul, MN; N. Carlson, University of Minnesota, Minneapolis, MN.

An elementary school had numerous indoor air quality complaints. The complaints included musty smells, allergic reactions, and headaches. Visible fungal growth was observed on about 1% of the carpet area in fifteen of the classrooms. The fungal growth was the result of excessive moisture in the concrete floor below the carpet wicking up into the carpet. The excessive moisture in the floor was a combination of inadequate landscaping and floor design. Because of budget problems, the design problems could not be corrected. A carpet cleaning firm convinced the school that with the use of proper cleaning and the use of sanitizers on the carpet that the fungal contamination in the carpet could be controlled. Micro-vacuum dust samples were collected before and after two different cleaning protocols were followed in six classrooms and these results were compared to two reference classrooms where the carpet was not cleaned. These dust samples were serially diluted and plated on 2% malt extract and DG-19 agar plates. The average fungal population from 12 samples collected in the two reference rooms increased from 5.2 million colony forming units per gram of debris collected (CFU/g) to 5.9 million, an increase of 13%. The average fungal populations from 18 samples collected in three classrooms where the carpet was hot water extracted using detergents decreased from 11.1 million to 9.6 million CFU/g, a decrease of 14%. The average fungal populations from 18 samples collected in three classrooms where the carpet was hot water extracted using detergents followed by sanitizer decreased from 3.8 million to 2.1 million CFU/g a decrease of 46%. Although, some reductions in fungal population were observed in the carpets that were cleaned verus carpet not cleaned, the reductions were not adequate to lower the fungal population to within normal levels found in carpet. All the carpet in this school had to be removed to solve this indoor air quality problem.

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CHARACTERIZATION AND CONTROL OF FUNGAL EXPOSURE DURING DOCUMENT RESTORATION AT THE NATIONAL ARCHIVES LABORATORY. C. Piacitelli, J. Harrison, W. Jones, NIOSH, Morgantown, WV.

In this study, we examined the exposures associated with the restoration of historical documents at the National Archives Laboratory in College Park, Maryland. When documents arrive with water damage and suspected mold growth, conservators use various mechanical means (vacuuming, brushing, wiping, and erasing) to remove contamination. This work can result in the generation of aerosols and is typically done within an exhaust hood. We examined the nature of this dust and determined ventilation hood effectiveness by light and electron microscopy analysis of air samples collected both inside and outside the ventilation hood during restoration of Civil War ship log documents. We also explored the effectiveness of treatment by microscopy examination of bulk samples of vacuumed and un-vacuumed documents. Additionally, personal and area real time dust measurements were made along with time-synchronized video in order to relate workplace dynamics to dust exposure. The predominant aerosol exposure here was confirmed to be of fungal origin. Although spores dominated, fragments of hyphae were also seen. Examination of the documents themselves revealed extensive fungal contamination. Although vacuumed documents showed markedly less surface contamination, fungal material could still be detected. Real time dust/video analysis was useful in pinpointing specific tasks which resulted in concentration spikes and this was used to recommend some rather simple changes in workstation configuration to eliminate these exposure peaks.

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AN INVESTIGATION OF FUNGAL CONTAMINATION IN A HOSPITAL SETTING. M. Johnson, C. Rao, K. Kreiss, NIOSH, Morgantown, WV.

An investigation was conducted at an 8-story hospital due to a reported cluster of work-related asthma on the eighth floor of the facility. There has been ongoing renovation throughout the building for the past 5 years. The occupants reported occasional severe water damage from roof leaks. Although, there were no obvious signs of mold contamination, fungi were suspected because of the occupant complaints and the historical water damage. A survey for fungal contamination was conducted on the two top floors of the facility. Spore trap sampling was performed inside the wall and in the ambient indoor air. Bulk samples of the ceiling were analyzed for fungal growth. The bulk sample analyses showed extensive fungal contamination (*Cladosporium elatum* and *Geomyces pannorum*) on the ceiling material. The in-wall spore concentrations ranged from 5.3×10^2 to 5.3×10^5 spores/m^3 (primarily of the genera *Aspergillus/Penicillium*, *Geomyces* and *Cladosporium*). Ambient indoor air concentrations ranged from 1.1×10^2 to 3.6×10^3 spores/m^3 in which the genera *Cladosporium* and *Geomyces* accounted for 30 to 60% of the total spore counts. We documented inter-floor pathways for migration of fungal spores between the wall cavities, the ceiling cavities and the occupied space. Spore concentration in the elevator was 3.6×10^3 spores/m^3, the highest quiescent ambient air level found in the facility. The elevator may have been a significant fungal pathway between floors. Our findings support the need for aggressive source and pathway identification even in the absence of visible mold or water damage.

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CHARACTERISTICS OF BIOAEROSOLS IN THE CHICKEN HOUSE. W. Lin, Chung Shan Medical & Dental College, Taichung, Taiwan Republic of China.

The characteristics of bioaerosols in a chicken house with different chicken age were evaluated. There were 8,000 chickens in the chicken house. The bioaerosol concentrations were measured at initial, middle and final growth stages with one, three and six weeks old, respectively. Triplicate bioaerosol samples were collected by AGI-30 impingers and Nuclepore filters at the flow rates of 12.5 L/min and 2 L/min, respectively. The sampling time was 30 min. Tryptic Soy Agar and Malt Extract Agar (Difco Lab.) were selected to recover bacterial and fungal colonies, respectively. When the chickens were 1 week old, the bacterial concentrations of filter and impinger samples were 7,640±1,200 CFU/m3 and 14,000±10,000 CFU/m3, respectively. In addition, the fungal concentrations of filter and impinger samples were 1,040±550 CFU/m3 and 1,170±870 CFU/m3, respectively. In the 3-week-old chicken houses, the bacterial concentrations of filter and impinger samples were 54,000±25,000 CFU/m3 and 190,000±11,000 CFU/m3, respectively. And the fungal concentrations of filter and impinger samples were 3,750±1,370 CFU/m3 and 5,340±180 CFU/m3, respectively. In the 6-week-old chicken houses, the bacterial concentrations of filter and impinger samples were 280,000±110,000 CFU/m3 and 580,000±170,000 CFU/m3, respectively. And the fungal concentrations of filter and impinger samples were 7,360±4,590 CFU/m3 and 11,800±3,740 CFU/m3, respectively. The results demonstrated that the bioaerosol concentrations in the chicken house increased when the chickens grew up, and would be more than 100-fold times that in normal environments. Moreover, it was found that the concentrations recovered from impinger samples were higher than that from filter samples.

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WHAT'S GROWING IN THE PACIFIC NORTHWEST? L. Swenson, GlobalTox, Portland, OR; C. Robbins, W. Geer, GlobalTox, Redmond, WA.

There has been increased media attention and public awareness about mold and mold exposures in the indoor environment. Since mold is ubiquitous and flourishes in the damp Pacific Northwest environment, there are many opportunities for industrial hygienists to assume key roles in indoor air quality and mold investigations for residential and commercial buildings. The industrial hygienist is asked to conduct sampling, to determine the presence or extent of mold, and to make recommendations for mold remediation. This paper presents the sampling methodology that we employ in indoor air quality investigations for mold. The types and quantities of fungal spores identified during sampling indoors and outdoors in the Pacific Northwest are presented. The methodology employed includes air sampling for viable and non-viable mold spores. Sampling is conducted outside, in unaffected areas (when possible), and in potentially affected areas. This combination of methods and locations provides excellent coverage in terms of maximizing information about airborne mold spores, while minimizing cost. Viable methods provide quantitative information about airborne mold spores and qualitative information concerning the species of actively growing mold. Non-viable methods provide information on total fungal particles present. This is useful because non-viable particles still retain their allergenic, irritant, and toxigenic properties. The combination of viable and non-viable sampling methods also provides clues when hidden sources of mold are suspected. Typically, in buildings without extensive water damage and mold growth, indoor mold levels have been about one-third of outdoor levels and genera/species present have been similar between indoors and outdoors. Viable counts have been about one-fourth of the total non-viable counts. Common fungal particles found in outdoor air samples include Ascospores, Basidiospores, Cladosporium, and

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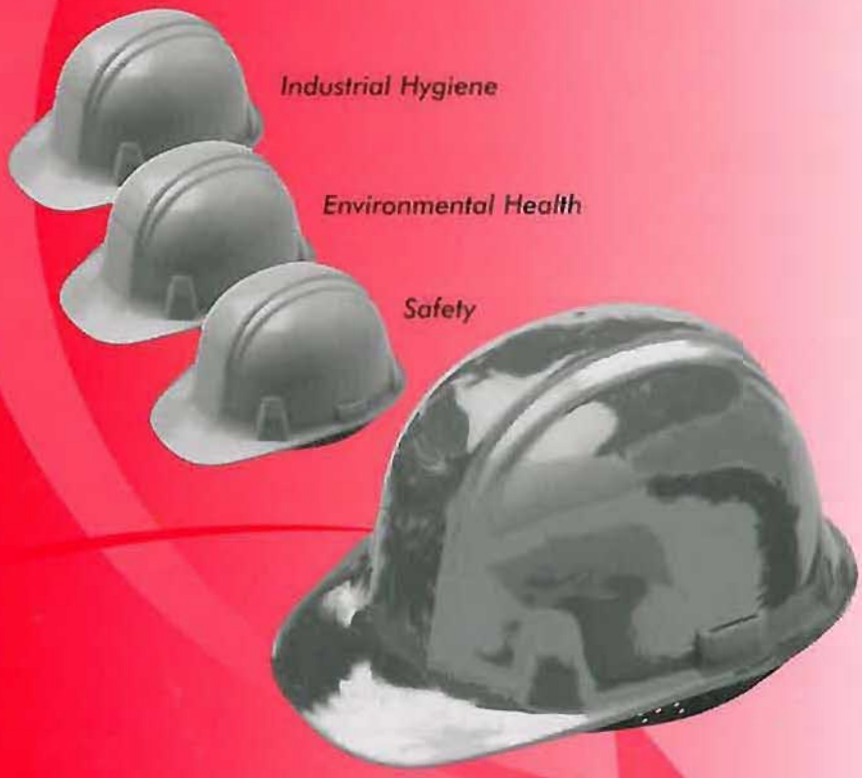

ABSTRACTS