ments was to produce laboratory penetration values above those allowed for approval using NIOSH test conditions. Prior to exposure in the field, all of the irradiated and isopropanol-dipped N95 and R95 filters had laboratory penetration values higher than permitted for approval using NIOSH test conditions. The irradiated P95 and P100 electret filters, as well as the isopropanol-dipped P100 electret filters, also had laboratory penetration values higher than permitted for NIOSH approval. The filters were then exposed to either a grinding aerosol or an oil mist in a steel foundry. Even filters with unacceptable laboratory performance performed adequately under field conditions. For the N95 filters exposed to the grinding aerosol, generally small but statistically significant differences in penetration were found among the three treatments. Only the isopropanol-dipped N95 filters from one manufacturer had mean field penetration greater than 1%. Mean penetration for the isopropanol-dipped mechanical P100 filters exposed to grinding aerosol exceeded the 0.03% penetration permitted for approval. None of the R or P filters permitted detectable penetration of the oil mist. Some untreated and irradiated N95 filters from both manufacturers were also exposed to the oil mist. No detectable oil mist penetration was found. These results indicate that current NIOSH approved N, R, and P series filters perform very well under typical workplace conditions. The worst-case conditions used in NIOSH testing provide a very large margin of safety in the event of exposure to degrading workplace conditions.

223.

DEVELOPMENT OF AN ABBREVIATED QUALITATIVE FIT TEST USING BITTER AEROSOL. T. Nelson, NIHS Inc., Ardentown, DE; L. Janssen, H. Mullins, M. Luinenburg, 3M, St. Paul, MN.

U.S. OSHA regulation 29 CFR 1910.134 requires qualitative fit tests (QLFT) to consist of seven, one-minute exercises. This procedure is time consuming, and the benefit of the exercise duration is unknown. This study was done to determine if qualitative fit tests done with 15-second exercises would produce pass/fail results equivalent to an accepted generated aerosol quantitative fit test (QNFT).

Advisory criteria for evaluating fit test methods outlined in Annex A2 to ANSI Standard Z88.10-2001 were used. A generated aerosol QNFT served as the reference method. The minimum passing fit factor was 100. Four models of elastomeric half facepiece respirator, each in three sizes, were used. Forty-three subjects participated in the study. Each subject passed a Bitrex™ taste sensitivity screening test before being assigned one of the respirators. Sequential QNFT and Bitrex QLFT were conducted in random order without disturbing the facepiece. Each test consisted of seven exercises. Exercise duration was 15 seconds for Bitrex and 60 seconds for QNFT. A total of 180 paired tests were conducted.

Data analysis revealed a test sensitivity of 0.91 for subjects who tasted Bitrex within 10 squeezes of the nebulizer bulb (level 1 taste sensitivity). This compares favorably with ANSI's recommended 0.95 sensitivity for new fit tests. In addition, binary logistic regression analysis revealed a 0.33 probability of passing the Bitrex test with a fit factor of 100 and a 0.20 probability of passing with a fit factor of 50. These probability values are nearly identical to those of the widely used ambient aerosol QNFT.

It was concluded that the 15-second Bitrex protocol sufficiently screens for adequate respirator fit in subjects with level 1 Bitrex taste sensitivity. The standard one-minute exercise protocol should be used for individuals with level 2 or level 3 taste sensitivity.

224.

THE EFFECT OF SUBJECT CHARACTERISTICS AND RESPIRATOR FEATURES ON RESPIRATOR FIT. Z. Zhuang, R. Berry Ann, D. Viscusi, NIOSH, Pittsburgh, PA.

A recent study was conducted to evaluate the accuracies of five fit-test methods for screening out poor-fitting N95 filtering-facepiece respirators. The fit of 18 models of NIOSH-certified, N95 filtering-facepiece respirators was assessed by using a simulated workplace protection factor (SWPF) test. The purpose of this companion study was to investigate the effect of subject characteristics and respirator features on respirator fit. The respirator features are design style (folding and cup style) and number of sizes available (one size fits all, two sizes, and three sizes). Thirty-three subjects (18 females and 15 males) participated in this study. They were measured for 12 facial dimensions with traditional calipers and tape. From this group, a panel of 25 subjects with face sizes 1 to 10 (based on the Los Alamos half-facepiece respirator fit-test panel) tested each respirator. The SWPF test protocol entailed using the Portacount PlusTM to determine a SWPF based on total penetration (face-seal leakage plus filter penetration) while the subject performed six simulated workplace movements. Six tests were conducted for each subject/respirator model combination with redonning between tests. Number of sizes available appeared to have some impact on respirator fit on the panel. There was no significant difference in the geometric mean (GM) fit factor between male and female subjects for 16 of the 18 respirator models. Subsets of one to six facial dimensions were found to be significantly correlated with fit factors in 28 of the 33 respirator model/respirator size combinations. Face width, bigonial breadth, nose protrusion, and face length were found in 11, 8, 8, and 5 of the 28 subsets, respectively. Lip length was found in only two subsets. Face length and lip length, which are used to define the current half-facepiece respirator fit-test panel, may need to be reconsidered when revising the panel.

225.

REAL-TIME END-OF-SERVICE-LIFE INDICATORS FOR AIR PURIFYING RESPIRATOR CARTRIDGES. E. DeMedeiros, J. Vincent, North Safety Products, Cranston, RI; K. Chapman, K&M Environmental Inc., Virginia Beach, VA.

Estimating service life of gas and vapor cartridges and preparing cartridge change-out schedules can pose problems to workers. Often, data required in the service life equations provided by the manufacturers are unknown or difficult to determine. To eliminate the need for cumbersome change schedules and simplify user training, end-of-service-life indicators (ESLIs) have been developed that are placed inside the gas and vapor cartridges to give workers real-time indication of cartridge service life. Gas and vapor cartridges with this ESLI technology have been developed for protection against toluene diiso-
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targeted contaminant indicating that the service life of the cartridge has expired. Performance assessments have been performed according to the requirements for the National Institut
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low humidity (25%RH). The basic gases cartridge was tested against ammonia at 1000ppm, 50%RH, 25°C, and 32 liters per minute (LPM) per cartridge. The acid gases cartridge was tested against hydrogen fluoride, hydrogen chloride, hydrogen sulfide, and sulfur dioxide at challenge concentrations of 70ppm, 500ppm, 1000ppm, and 500ppm, respectively, 50%RH, 25°C, and 32 liters per minute (LPM) per cartridge. The organic vapor cartridge was tested against TDI at 5ppm, 50%RH, 25°C, and 32 liters per minute (LPM) per cartridge. The basic gases cartridge has been approved for ammonia, the acid gases cartridge has been approved for hydrogen fluoride, hydrogen chloride, hydrogen sulfide, and sulfur dioxide and the OV cartridge has been approved for toluene diisocyanate.

226.

WORKPLACE PERFORMANCE ASSESSMENT OF HALF-FACEPIECE RESPIRATORS IN ISOCYANATE-EXPOSED BODY SHOP WORKERS: THE SPRAY STUDY. Y. Liu, J. Sparer, M. Stowe, F. Walsh, C. Holm, C. Redlich, M. Cullen, Yale University, New Haven, CT; D. Bello, F. Young, S. Woskie, University of Massachusetts, Lowell, MA; R. Streicher, NIOSH, Cincinnati, OH.

Little has been conducted to evaluate workplace performances of respirators in auto body

shops. This study was designed to assess the workplace protection factor (WPF) of half-facepiece cartridge respirators with paint filters in spray paintings as part of the Yale SPRAY study. Twenty-two auto body shops participated in the assessment with 30 inside-outside respirator sample pairs collected. Respirators assessed were from 3M and Survivair companies as used by shop workers. Air sampling and analysis was performed according to the NIOSH MAP draft method. The ambient air samples were collected using a 25-mm IOM sampler with a single quartz fiber filter operated at 2 l/min. The inside-respirator samples were taken using a Delrin cassette and the same filter with a probe mounted into the respirator facepiece. Filters were impregnated with 500ug MAP and field extracted with 10 ml 1x10-4 M MAP in acetonitrile. Samples were analyzed on HPLC. The monomer ($\mu g/m^3$) of hexamethylene diisocyanate (HDI), and oligomers ($\mu g/m^3$) of HDI and isophorone diisocyanate (IPDI) were quantified and total number of isocyanate reactive groups (TRIG: µgNCO/m3) calculated. WPF was calculated as the ambient concentration divided by the inside-respirator concentration. Results showed that geometric mean (geometric standard deviation) and range of WPF were 17.8 (5.1) and 1.0 to 204.0 for HDI monomer, 310.5 (6.9) and 6.8 to 9777.0 for HDI oligomers, 233.9 (12.2) and 1.0 to 85783.0 for IPDI oligomers, and 274.2 (6.0) and 0.6 to 5335.2 for TRIG. Average WPF of TRIG was 253.8 (6.5) for clear coating (N=25) and 403.8 (4.3) for priming (N=5) tasks without statistical significance. No significant difference was observed of WPF between respirator brands. These results provided essential data for assigning protection factors to these respirators when used in spray operations and for adjusting internal exposures to isocyanates in the SPRAY epidemiologic study of health effects.

227.

AUTOMATED BREATHING AND METABOLIC SIMULATOR (ABMS) CO_2 TEST FOR POWERED AND NON-POWERED AIR-PURIFYING RESPIRATORS, AIRLINE RESPIRATORS, AND GAS MASK. E. Sinkule, N. Turner, S. Hota, NIOSH, Pittsburgh, PA.

There is currently no NIOSH certification test for CO_2 concentrations in air-purifying respirators. The Automated Breathing and Metabolic Simulator (ABMS), which simulates human metabolism, minute ventilation, and breathing waveforms, was used to characterize average inhaled CO_2 in a variety of NIOSH-approved air-purifying respirators. An ABMS CO_2 test protocol was developed to test 11 powered air-purifying respirators (PAPRs), 20 airline respirators (SARs), six gas masks, 27 P-100 air-purifying respirators (APRs), and 26 filtering-facepiece N95 respirators (N95s). The ABMS CO_2 protocol consisted of the following levels of O_2 consumption, CO_2 production, and minute ventilation performed consecutively for a minimum of five minutes each: 0.5, 0.4, and 10 L/min STPD; 1.0, 0.8, and 25 L/min STPD; 1.5, 1.3, and 38 L/min STPD; 2.0, 1.9, and 62 L/min STPD; 2.5, 2.5, and 70 L/min STPD; and 3.0, 3.1, and 80 L/min STPD, respectively. The mean across all PAPR models for average inhaled CO_2 and O_2 ranged from 0.2% and 20.7%, respectively, for the lowest metabolic rate to 0.9% and 20.0%, respectively, for the greatest metabolic rate. The mean across all SARs for average inhaled CO_2 and O_2 ranged from 0.5% and 20.3%, respectively, for the lowest metabolic rate to 0.4% and 20.5%, respectively, for the greatest metabolic rate. The mean across all gas masks and APRs for average inhaled CO_2 and O_2 ranged from 2.6% and 17.5%, respectively, for the lowest metabolic rate to 0.7% and 20.4%, respectively, for the greatest metabolic rate. The mean across all N95s for average inhaled CO_2 and O_2 ranged from 3.5% and 16.8%, respectively, for the lowest metabolic rate to 2.7% and 18.6%, respectively, for the greatest metabolic rate. These data demonstrate the wide range of average inhaled CO_2 concentrations across respirator types and the utility of the ABMS in conducting CO_2 testing.

228.

NIOSH CBRN RESPIRATORY PROTECTION STANDARDS UPDATE. J. Dower, L. Boord, NIOSH, Pittsburgh, PA.

Emergency response forces in the United States are required under federal regulations to provide NIOSH approved respirators appropriate for the expected hazards. NIOSH's National Personal Protective Technology Laboratory (NPPTL) is developing respirator standards for use in chemical, biological, radiological, and nuclear (CBRN) terrorism events. These efforts to develop appropriate respiratory protection standards started with an assessment of potential CBRN terrorism agents and a review of national and international respiratory protection standards. Based on results of the threat assessment and standards review a comprehensive program to develop CBRN standards for each class of respiratory protection. In December 2001, NIOSH announced the first CBRN respirator standard for compressed air self-contained breathing apparatus (SCBA). This standard combines a three-tier approval structure: NIOSH industrial SCBA approval, National Fire Protection Association (NFPA) 1981 Standard compliance, and special performance tests against chemical warfare agents and facepiece protection levels. Continuing standards development efforts have focused on the full-facepiece air-purifying respirator standard and an air-purifying escape respirator standard. Standards concepts and future standards schedules will be discussed.

229.

THE RELIANCE ON MATERIAL SAFETY DATA SHEETS FOR RESPIRATOR SELECTION. T. Towers, U.S. DOL/OSHA, Washington, DC.

In March of 2002 the U.S. Department of Labor's Bureau of Labor Statistics published a report on the use of respiratory protection in industry, titled *Survey of Respirator Use and Practices*. Of companies surveyed, 57% reported using Material Safety Data Sheet (MSDS) information for guidance in respirator selection.

A 1991 GAO report, *The Accuracy of Material Safety Data Sheets* reported that the accuracy of MSDSs in four areas: health effects, first aid, personal protective equipment, and exposure limits was 11% of the sampled MSDSs. Information on personal protective equipment was judged accurate in 47% of the MSDSs, inaccurate in 22% of the MSDSs, and partially accurate in 31%.

Concerned that as many as 57% of American companies whose employees rely on respiratory protection may be ill-advised when making respirator selection decisions, a study was conducted to determine the accuracy of respiratory protection information contained in a small sample of MSDSs obtained from sources on the Internet.

One hundred MSDSs which met the following criteria were examined. MSDSs would be (1) selected from a website linked to OSHA's website, (2) for a chemical with a known exposure limit: PEL, TLV, REL, etc, and (3) dated after the publication of OSHA's Respiratory Protection Standard, 29 CFR 1910.134.

Once the MSDSs were selected, they were evaluated according to the amount and type of respiratory protection information contained therein. The MSDS information was then categorized in one of three ways: (1) Accurately recommended a respirator. May have included NIOSH approval, APF, ESLI, changeout recommendation, warning properties, IDLH, respirator type according to contaminant concentration, etc. (2) Recommended a respirator, but did not elaborate enough to aid in proper selection. (3) Did not recommend respirator when one was indicated by the NIOSH Pocket Guide; or stated that "approved respirator" should be used.

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295.

CDC/NIOSH EMERGENCY RESPONSE: THE WORLD TRADE CENTER DISASTER—A LOOK AT THE CHAOTIC CONDITIONS AND RESCUE WORKERS' EXPOSURES. D. Mattorano, G. Burr, K. Wallingford, E. Synder, B. Bernard, E.

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