

Results for indoor jackhammering, with no dust control, confirm previous personal monitoring results that indicate exposure to silica at many times current published occupational standards and guidelines. Depending on length of operations, however, all personal sampling results indicate the possibility that employee exposures may be near or above occupational standards and guidelines regardless of the procedure performed. This issue will be more important when comparing personal sampling results to the 1999 proposed ACGIH TLV® for crystalline silica, as quartz, which will halve the current TLV.

The sampling results support the recommendation that wet dust control methods are an important engineering control for reducing silica exposure during jackhammering. Further research will also be presented for developing dry-dust control methods. Work was performed under the auspices of U. S. Department of Energy by the Lawrence Livermore National Laboratory under contract W-7405-Eng-48.

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**NOISE CONTROL IN HIGHWAY CONSTRUCTION.** K. Ahn, University of Massachusetts-Lowell, Lowell, MA; S. Moir, University of Massachusetts-Lowell/Construction Occupational Health Project, Lowell, MA

Noise is omnipresent in construction and practical solutions are difficult to introduce and evaluate. A construction contractor with a demonstrated commitment to reducing worker exposure to health hazards asked researchers to evaluate noise on a highway site and make recommendations for a noise control program. Investigation identified three sources of noise: a drill rig, generators, and hand tools for bolting reinforcing bars. Monitoring showed differences in sound levels and frequencies among the sources. Researchers made several recommendations to improve the contractor's noise control program:

- 1) A simple practical method was developed for quickly measuring noise levels on tools and equipment and determining "noise perimeter zones." Only designated workers would be permitted within the "noise perimeter zones," and appropriate personal protective equipment (PPE) and administrative controls would be instituted within the zones.

- 2) Once the noise level of tools and equipment was documented, high level sources would be evaluated for engineering controls, including mufflers/silencers, isolation, enclosures/barriers, and the addition sound-absorbing material.

- 3) Noise control would be a regular component of purchasing specifications and maintenance procedures. Training in noise control methods would be provided to maintenance personnel.

- 4) Standard-issue foam earplugs are insufficient to protect hearing in many construction work environments. Hearing protection would be selected to be protective in the worker's specific environment.

The contractor's attempts to apply the recommendations were evaluated. Recommendations proved feasible in the field under ideal conditions, but the contractor accurately predicted factors that reduced effectiveness. Multiple sources of noise create areas of complex exposure not well characterized by monitoring at a single source; and enclosed areas resulted in reverberation that accentuated noise levels. Any noise control program must account for these factors.

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**SILICOSIS PREVENTION AMONG HISPANIC CONSTRUCTION WORKERS: DEVELOPING CULTURALLY APPROPRIATE HEALTH MESSAGES.** D. Tan-Wilhelm, K. Williams, III, R. Massengale, J. Welbourne, K. Clough, C. Ellison, NIOSH, Morgantown, WV

More than 14,000 workers in the United States have died from silicosis, and hundreds more add to the death toll each year. In the state of Texas, 300 cases of silicosis and workers exposed to silica were reported between 1990 and 1997. Among these cases, construction was one of the most frequently reported industries. One-third of the silicosis cases were found among Hispanic workers, most of whom were diagnosed in their thirties. Despite the alarming number of reports and the increasing representation of Hispanics in the work force, few attempts have been made to educate workers of Hispanic or Latino descent.

To develop culturally appropriate silicosis-prevention messages, we conducted 11 focus group interviews among 112 Hispanic construction workers in Texas. The results indicated that most workers were unaware of silicosis and most knew little about the cause and health effects of silicosis. Barriers to prevention included lack of knowledge about the risk of silica exposure and prevention methods, lack of proper protective equipment, time constraints, discomfort associated with wearing respirators, and not being able to read provided health and safety information.

Being able to live long with one's family was an important reason these workers wanted to protect themselves. The workers' most preferred channel to obtain health and safety information was through training sessions, and their most credible sources of health and safety information were physicians or nurses.

Based on the focus group results, we conclude that silicosis prevention messages should target both workers and employers. Messages designed for workers should emphasize the importance of family, be available in Spanish, and preferably be delivered through a training session by a clinician. The information collected in this study will be used to design a silicosis prevention program in Texas.

## Evaluation of Protective Clothing Effectiveness and Its Impact on Workers Papers 159-164 159

**LABORATORY EVALUATION OF THREE PERSONAL HEAT STRAIN MONITORS IN YOUNG AND OLDER WEARERS OF PROTECTIVE CLOTHING.** N. Turner, E. Sinkule, W. Eschenbacher, D. Freeland, NIOSH, Morgantown, WV

NIOSH has recommended that worker-acceptable physiological monitoring may be an effective alternative to environmental monitoring in extreme environmental conditions. This study evaluated the accuracy of three commercial personal heat strain monitoring systems: 1) Metrosonics hs-3800®; 2) Mini-Mitter Vital Sense®; and 3) Questemp II®.

Seven young (25-40 years) and seven older (40-55 years) men wore two different protective clothing ensembles in similar environments: 1) single-layer cotton/polyester coverall at 35°C WBGT (COTTON); and 2) vapor-impermeable Level A suit

with SCBA at 29.5°C WBGT (HAZMAT).

Subjects walked on a treadmill at a low intensity until rectal temperature reached 38.5°C or until volitional fatigue. Mean work times ranged from 41.9 min to 51.7 min. Sensitivity for the Metrosonics and Vital Sense was 0.00 and 0.00 for COTTON and 0.38 and 0.71 for HAZMAT, respectively. Specificity was 1.00 for the Metrosonics and Vital Sense for both conditions.

When rectal temperature measured 38.5°C, mean disk temperatures for the Metrosonics and Vital Sense were 38°C and 37.5°C for COTTON and 38.2°C and 38.2°C for HAZMAT, respectively. Questemp ear canal temperatures in the young subjects were 39.1°C and 38.7°C for COTTON and HAZMAT, respectively; in the older group, Questemp temperatures were 39.4°C and 37.7°C for COTTON and HAZMAT, respectively. Correlation coefficients between rectal temperature and Metrosonics, Vital Sense, and Questemp temperatures were 0.09, -0.04, and 0.10 for the COTTON condition and 0.79, 0.76, and 0.03 for the HAZMAT condition, respectively.

The accuracy of Metrosonics and Vital Sense was poor for the COTTON condition. While significant correlations for both Metrosonics and Vital Sense and better sensitivity for Vital Sense were observed during the HAZMAT condition, there was an unacceptably high number of false negatives for both systems. The Questemp performed poorly for both groups and conditions.

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**EFFECTIVE COOLING RATES OF EIGHT PERSONAL COOLING SYSTEMS.** P. Fernandes, Chastain-Skillman, Tampa, FL; I. Richards, T. Bernard, University of South Florida, Tampa, FL

When evaporative cooling is restricted, personal cooling may be the only practical means of reducing heat strain. Common methods to choose a personal cooling system include testimonials of other users, limited field trials, and user feedback. Laboratory comparisons using mannequin or wear trials provide a more reliable means of comparison. Wear trials provide the most useful information because they are repeatable simulations of actual use conditions.

Because there is no standardized testing method, there is no consistency among laboratory protocols. The basic approach is an experimental design that compares cooling systems with a control and with each other under a limited number of conditions. This method was followed in the evaluation of eight commercially available cooling systems.

The clothing ensemble was a limited-use vapor-barrier coverall with hood. The subject wore a full-mask respirator while working at a metabolic rate of 290 W. To generalize the analysis, the effective cooling construct was developed. The effective cooling rate was the metabolic rate minus the heat storage rate where the contributions from evaporative cooling and the environment were negligible. The no-cooling control had the least safe exposure time of 30 minutes and an effective cooling rate of 30 W. Two liquid cooling vests followed at about 45 minutes and cooling rates of 100 W, followed by an ice vest at 60 minutes and 165 W, and another liquid cooling vest at 80 minutes and 200 W. When more body surface area was covered by either liquid cooling systems (jacket with hood and full suit) or one of two vortex air cooling systems, the safe times were extended to the trial time of 120 minutes and cooling rates were greater than 225 W.

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