The most efficient method determined for drilling, sediment sampling and piezometer installation was to use the ice as a platform to perform these activities. A procedure and worksheet was developed and successfully used which incorporated engineering methods for determining the load-bearing capacity of the ice. The load-bearing capacity of an ice sheet is more than just a function of the overall thickness of the ice. Research has determined other factors that affect an ice-sheet's load-bearing capacity, which include

(1) Ice strength, the white ice layer of an ice sheet contains entrained air and has one-half the strength of clear ice.

(2) Wet cracks or fissures reduce the strength of ice by one-half.

(3) Ambient air temperatures above freezing for more than 6 hours during the past 24 hours reduce ice strength by approximately 30%.

(4) When a vehicle or load remains on an ice sheet for more than 2 hours, a safety factor of 2 must be used for calculating ice strength.

(5) Other conditions that decrease the load-bearing capacity of ice sheet include snow accumulation on the ice, lack of water support under the ice and vehicle speeds above 15 mph.

A worksheet was developed which incorporated the above factors that affect ice strength. The procedures used to quickly and accurately measure and calculate the load-bearing capacity of ice will be discussed and illustrated. Conclusions and findings from this work will be presented.

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MUSCULOSKELETAL INJURIES IN CONSTRUCTION: A REVIEW OF THE PROBLEM. S. Schneider, Center to Protect Workers' Rights, Washington, DC

Construction workers have very ergonomically challenging work. They must work in awkward postures, frequently lift and move heavy materials manually, and much of their work is done at ceiling and floor level. It is not surprising then that they suffer from a disproportionate share of musculoskeletal injuries. During discussions in the US on developing regulations for the prevention of musculoskeletal injuries in construction, contractor associations expressed scepticism about the scope and nature of the problem. This review is, in part, a response to that challenge. In it we review the evidence for a musculoskeletal disorders problem in construction based on historical reports, injury data sources, workers' compensation data, symptom and injury surveys of construction workers, and published literature. Specific musculoskeletal injury problems which are well-documented in the literature are also discussed. The work-related musculoskeletal injury problem in construction is large and can be reduced significantly through interventions such as workplace modifications and administrative changes.

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SLURRY WALL CONSTRUCTION AND ASSOCIATED HEALTH HAZARDS. T. D. Schell, A. Kalil, B. Buchholz, S. Woskie, Construction Occupational Health Project, Department of Work Environment, University of Massachusetts Lowell, Lowell, MA

Using an integrated ergonomic-industrial hygiene approach, health hazards of slurry wall construction were examined. This construction method allows for excavations to great depths without shoring through the use of water-based slurries as stabilizing agents. This slurry operation was part of the Central Artery construction project in Boston, MA, and required excavation of 135 foot deep trenches. A team of 9 researchers monitored 25 laborers and operating engineers in order to gain an understanding of the associated hazards. This study utilized the following methods: ergonomic job analysis, PATH (Posture, Activities, Tools and Handling analysis) a work sampling-based approach, personal noise dosimetry and air sampling. Preliminary analyses using EJA's and PATH suggest that this job is not ergonomically hazardous, since the worker was frequently standing in a neutral posture observing the operation. One activity with significant stressors was the disassembly of the tremmy pipe which required forceful exertions by the worker. Since the excavation process relies on a water-based slurry, removing materials from the trench generates limited dust. Personal air sampling indicated low PNOC and free silica levels relative to other construction operations. Analysis of respirable samples for diesel exhaust showed low levels compared with the proposed ACGIH TLV. Activities other than excavation generated higher dust levels. The heavy machinery used during some processes creates the potential for high noise exposures. Personal noise monitoring during excavations showed TWA sound levels from 85–90 dBA for laborers and operating engineers, while procedures related to the concrete pour had noise levels greater than 100 dBA. These data indicate that the slurry wall method involves few hazards in comparison with other excavation methods that have been analyzed.

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TIME-WEIGHTED POSTURE INTENSITY EXPOSURE ASSESSMENT OF CARPENTRY TASKS AT CONSTRUCTION SITES. A. Bhattacharya, Y. Li, G. Lemasters, University of Cincinnati, Cincinnati, OH; M. Dimov, R. Stinson, Greater Cincinnati Occupational Health Center, Cincinnati, OH

As carpentry tasks have a long cycle time, a posture intensity assessment should include contribution of time associated cumulative changes in the posture. At 16 construction sites, 33 hours of arm and back posture data were collected on 22 carpenters using a portable ergonomic dosimeter in order to quantitate time-weighted posture exposure intensity associated with ergonomic loading for 3 carpentry specialties: ceiling, drywall and form work. The time dependent data (collected every one second) of arm and back posture angles were assigned a weighting according to a second order polynomial expression of "neutral," "low," "medium," "high," and "very high" risk posture categories. For the arm posture, the weights were "Neutral ($-20<\alpha<20$)" :: $1^2/14$; "Low ($20<\alpha<45$)" :: $1^2/14$; "Medium ($45<\alpha<90$)" :: $1^2/14$; "High ($90<\alpha<135$)" :: $2^2/14$ and "Very High ($135<\alpha$)" :: $3^2/14$. Similar weightings assigned for back postures were: "Neutral ($-20<\alpha<20$)" :: $1^2/14$; "Low ($20<\alpha<45$)" :: $1^2/14$; "Medium ($45<\alpha<90$)" :: $2^2/14$ and "High ($90<\alpha$)" :: $3^2/14$. The total weight=12+22+32=14. These weightings were assigned to every data point for each carpenter. With the above weighting strategy the posture exposure intensity was then calculated as the time-weighted average (TWA) value. The results show that arm loading for ceiling task (TWA 7.4 +/- 5.7) was significantly higher than that for form work task (2.2 +/- 0.55); back loading for ceiling task (3.3 +/- 1.65) was significantly lower than that for form work and drywall (9.7 +/- 5.0, 5.7 +/- 2.2). In summary, the method used to quantitate and characterize posture loading allowed us to include the contribution of time dependent changes in postures associated with carpentry tasks.

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CARPENTERS' PERCEIVED EXERTION AND BODY DISCOMFORT SYMPTOMS ASSOCIATED WITH THEIR TASKS—AN ON-SITE EVALUATION. M. Dimov, H. Applegate, R. Stinson, Greater Cincinnati Occupational Health Center, Cincinnati, OH; A. Bhattacharya, Y. Li, G. Lemasters, University of Cincinnati, Cincinnati, OH; L. Greathouse, Texaco, Inc., Houston, TX

The purpose of this study was to determine how carpenters subjectively perceived the exertion level and body discomfort associated with their daily tasks. Two psychophysical instruments were utilized in this study. The Borg's whole body physical exertion instrument, a measure of overall physical demand, and the body segment (modified Bishop-Corlett Scale) instrument, a measure of rating pictorial body segmental discomfort, were given to 65 carpenters at the work site after the end of their shift. Carpentry specialties evaluated on-site were ceiling, drywall, concrete form work, finish work, piledriving, fixtures, welding, and scaffolding. The mean Borg's score for the subjects combining all specialties was 14.4 (2.4 SD), a score between "somewhat hard" and "hard," for perceived overall physical effort demanded by the task. Results indicate that the perception of whole body physical exertion was a direct indication of the specific task-associated exertion and was not influenced by age nor the number of years as a carpenter. The findings from the body segment discomfort scale of the total group, indicates that the top three discomfort frequency by body segments were mid- to lower back (54.6%). knees (41.7%), and the neck (35.3%). Significant differences by body segment discomfort in a multivariate comparison among specialties appeared for two specialties: drywall, with back (63.3%) and knee (54.5%) discomfort were higher than other body segments ($p=0.03$); and finishing, with hand/wrist (80.0%) higher than all other body segments ($p=0.03$).

Project funded by National Institute for Occupational Safety and Health and work performed at the Greater Cincinnati Occupational Health Center.

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ERGONOMICS AND ROOFING: THE PROBLEM AND A PARTICIPATORY APPROACH TOWARDS SOLUTIONS. S. Schneider, Center to Protect Workers' Rights, Washington, DC; T. Cook, University of Iowa, Iowa City, IA

Roofing work is one of the most dangerous jobs in construction, which itself is one of the most dangerous industries. While falls are an important part of the injury picture in roofing, musculoskeletal injuries are equally, if not more important. Injury data, workers' compensation data, insurance company data, symptom surveys and a few ergonomic studies have highlighted the injury profile for this trade and defined the scope of the problem. Field work and discussions with union members and contractors have identified several tasks performed by roofers which are more likely to be associated with musculoskeletal stress. Tasks like tear-off of old roofing require the most manual effort and have become the focus of a participatory research effort involving the roofers union, roofing contractor association, their insurance carrier, and researchers. Several ergonomic stresses have been identified during roof tear-off work and solutions have been recommended. Recommendations will be reviewed and prioritized by the participatory research team, implemented and evaluated. Evaluations will involve both subjective and objective assessments. Evaluations of productivity improvements will be included as well.

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BRIGHT IDEAS: CONSTRUCTION WORKERS' ERGONOMIC INNOVATIONS ON THE JOB. D. Wigmore, S. Moir, University of Massachusetts, Lowell, MA

Construction workers face many health and safety hazards in an industry that constantly changes its work spaces but it is slow to change its work methods and processes - officially. But the story is often different once you scratch the surface, for many workers constantly make changes and invent ways to do their jobs differently. As part of its work on a large highway construction project in the Boston area, the Construction Occupational Health Project has started to look for and record the "Bright Ideas" workers devise to make their jobs easier and healthier. The emphasis has been on finding worker-designed ergonomic measures to "fix the job, not the worker", ones that use your brain, not your back". Examples include a replaceable post and bracket safety railings system, a tilesetter's trowel turned into a spatula, a clamp to allow workers to lift and maneuver heavy beam holders and knee-saving devices and methods. The project methodology includes: spending time on site to become familiar with the work and the people working there; asking workers and supervisors for leads and help; taking pictures of before and after situations and sharing them with those who are photographed; talking to the innovators and their co-workers about their problem solving processes and the usefulness of the solutions; writing up the results in a one-page brochure which is reviewed by those interviewed and other workers for accuracy and clarity; and distributing the brochure on site, within the industry and through a national construction occupational health consortium. The brochures are used on site to both explain the "Bright Ideas" project and to inspire others to contribute. In general they provide a route for discussion of the possibilities of health and safety improvements on this project and in construction work in general.

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THE ROLE OF THE INTERNATIONAL LABOUR ORGANIZATION (ILO) IN SHAPING THE FUTURE OF OCCUPATIONAL SAFETY AND HEALTH. N.T. Watfa, International Labour Office, Geneva, Switzerland

The International Labour Organization (ILO) was established in 1919 with a constitutional principle that promotes social justice and a strong mandate for the protection of working men and women from occupational injuries and diseases. Its emergence from the chaos of World War I entrusted it with social reform which accompanied the Industrial Revolution. As a specialized agency of the United Nations, the ILO enjoys a unique tripartite (governments - employers - workers) structure. It engages in the formulation of international socio-labour policies, the creation of international labour standards (Conventions), international technical cooperation and in training, education, research and information dissemination. The majority of the 176 Conventions and 183 Recommendations developed by ILO so far deal directly or indirectly with occupational safety and health. The ILO Occupational Safety and Health Convention (No. 155), 1981, calls for coherent national policies on occupational safety and health and the working environment. Of the more recent standards are those which concern chemical safety, the prevention of major industrial accidents, and mining safety. The elimination of child labour, a pressing issue in the employment of children in hazardous occupations, will be dealt with by future Conventions. These Conventions become national legislations upon ratification by member states of the ILO, which adds more to the harmony of the field at the international level. The ILO plays a major role in the future of occupational safety and health because it promotes the harmonization of occupational safety and health standards worldwide, which is crucial to the globalization of the economy and to the transfer of technology, given their direct impact on the safety and health of the working people.

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WORK IMPROVEMENTS IN SMALL ENTERPRISES (WISE) SUCCESS STORIES IN THE PHILIPPINES. R. Rinehart, Harvard School of Public Health, Cambridge, MA; J. Batino, Philippines Department of Labor and Employment, Manila, Phillipines; W. Salter, International Labor Organization, Manila, Phillipines

Work Improvements in Small Enterprises (WISE) is an action-oriented program that aims to demonstrate to entrepreneurs that better working conditions can result in higher productivity and improvements in the quality of work. Since 1993, the Philippines Department of Labor and Employment, with support from the International Labor Organization and sponsorship by the United Nations Development Program, has conducted WISE training workshops for more than 350 small business entrepreneurs throughout the Philippines. This presentation describes the development of a series of success stories designed to highlight and promote the WISE program.

The speaker visited fifteen small enterprises in the Philippines from March to April 1996 that had previously participated in WISE training workshops. The industrial sectors represented by the enterprises included metal forging, electroplating, printing, garments, pigments, inks, furniture, cardboard recycling, and food. During each factory visit, owners and managers were interviewed to assess improvements in the working environment made as a result of participation in WISE. Walk-through tours of each factory were then made to observe improvements and workers were asked to provide their impressions. From the fifteen factories visited, seven success stories were written. Each success story, following a standardized format, highlights a single enterprise and represents "success" through the eyes of the entrepreneurs including their perceptions of increased productivity due to better working conditions. This presentation introduces the process of developing the WISE success stories and the issues related to building credibility among small-scale entrepreneurs with programs like WISE.

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EXPOSURE TO CARBON BLACK IN THE EUROPEAN MANUFACTURING INDUSTRY — DATA FROM 1987 TO 1995. K. Gardiner, University of Birmingham, M.J.A. van Tongeren, I.A. Calvert, J.M. Harrington, Institute of Occupational Health, The University of Birmingham, Edgbaston, Birmingham, United Kingdom

Carbon black is a very fine and pure carbonaceous particle manufactured by the vapour phase pyrolysis of mainly aromatic oils. In Europe it is manufactured in 16 factories in 7 Countries. Since 1987, these factories have been taking part in a study of respiratory morbidity which, so far, has included three cross-sectional surveys of both exposure and health outcome measures. Exposure to inhalable and respirable dust has been assessed by means of the Institute of Occupational Medicine (IOM) and SIMPEDS cyclone sampling heads, respectively. Pulmonary function

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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.

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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.

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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