concentration. This approach is an alternative to activity-based sampling (ABS), currently the only method to obtain inhalation exposure estimates. Collocated, simultaneous RAFS and ABS tests at 12 locations in the U.S. provided data to validate the RAFS-Model approach. **Results:** Asbestos emission rates generated by the RAFS are highly correlated with ABS measured concentrations (R2 = 0.98), but over-predict exposure (slope = 14) because of the RAFS measured asbestos emissions at the soil surface. RAFS measured concentrations vary from 2 fibers per cc to 0.001 fibers per cc. The breathing zone model accurately predicted actual exposure concentrations measured by ABS. Breathing zone concentrations ranged from 1 fiber per cc to less than 0.0001 fibers per cc. Regression statistics showed the slope equaled unity, intercept was zero, and the R2 was still greater than 0.90. **Conclusions:** The research conclusions support the RAFS-Model approach as an accurate, reliable and economical alternative to ABS for assessing the occupational and public health risk from asbestos exposure at contaminated sites. Further research will associate chronic, low-level asbestos exposure to one's lifetime risk of developing cancer.

Podium Session 102 Ergonomics: Shoulders, Back and Lower Extremities

Monday, May 16, 2011
10:30 a.m.–12:30 p.m.
Papers PO 102-1–PO 102-6

PO 102-1
Risk Factors Associated with Low Back Injuries among University Residence Hall Employees Based on Ergonomic and Lifestyle Choices

B. Bidassie, J. McGlothlin, Purdue University, West Lafayette, IN.

Objective: Lower Back (LB) injuries account for a significant amount of human suffering, loss of productivity, increases in workers' absenteeism rates among university residence halls (URH), especially those with dining halls. Many thousands of employees perform physically demanding occupational tasks in URH which can result in an LB injury presenting a major economic burden on workers' compensation systems. Recent studies have suggested that there may be a relationship between LB injuries, occupational risk factors and lifestyle choices. **Methods:** Three years ago, a university initiated a program to improve the quality of the workplace through ergonomic interventions and a healthy lifestyle (WorkLife) program. Four hundred and sixty-eight (468) URH employees each filed a workers' compensation claim for a workplace injury and also participated in the WorkLife program. Of the 468 participants, 49 (10.5%) reported that they had an LB injury. A study to determine if there was a relationship between work risk factors and lifestyle choices was conducted in three phases: 1) an ergonomic evaluation to address work risk factors for LB injuries; 2) qualitative evaluation of lifestyle choices from Purdue's Worklife Program; and 3) development of LB injury model to determine the relationship between work risk factors and lifestyle choices for URH workers. **Results:** A logistic regression model showed that URH employees are more likely to get an LB injury based on the following risk factors: daily activities involving lifting/twisting/bending, reporting a slip, trip or fall, being between the age of 30-40 years, sleeping less than 8 hours daily, having one or more dependents, and reporting not handling stress very well. **Conclusions:** These results may be helpful when developing strategies for reducing and preventing LB injuries among URH workers

PO 102-2
Can Adding a Seat Cushion Reduce Exposure to Whole Body Vibration?

S. Chervak, U.S. Army, APG, MD.

Objective: An association between driving vehicles and low-back pain has been well documented. One potential cause of low-back pain is the occupants' exposure to Whole Body Vibration (WBV). Often occupants of vehicles will use a supplemental seat cushion to lessen exposure to WBV experienced while in the vehicle's seat. **Methods:** A military High Mobility Multipurpose Wheeled Vehicle (HMMWV) was instrumented with vibration measurement equipment in order to determine if the addition of a supplemental seat cushion would lessen the occupants' exposure to WBV. The HMMWV was instrumented with four seat pad accelerometers placed on the driver and front passenger seats, above and below the supplemental seat cushion. The vehicle was tested over five test tracks to replicate conditions typically encountered in combat and garrison. WBV data was collected and processed according to ISO 2631-1:1997. **Results:** An Analysis of Variance was conducted on the Weighted Root Mean Square (Wrms) vibration values measured above and below the supplemental seat cushion. The Wrms vibration values measured above the supplemental seat cushion were significantly higher than the Wrms vibration values measured below the supplemental seat cushion on four of the five test tracks. **Conclusions:** In our evaluation, the ability of a supplemental seat cushion to reduce vehicle occupant's exposure to WBV was not evident. The need to develop a seat cushion that can absorb or dissipate low frequency vibration would greatly reduce vehicle occupant's exposure to WBV

PO 102-3
Whole Body Vibration in Snow Removal Loader Operations: Do Traction Chains Cause Low Back Pain?

R. Blood, P. Rynell, P. Johnson, University of Washington, Seattle, WA.

Objective: The goal of this study was to compare whole-body vibration (WBV) exposures between three front-end loader tire conditions. Research has indicated there is a relationship between working as a heavy equipment operator and the development of low back pain. **Methods:** Using a repeated measures design and a standardized test route, whole body vibration exposures were compared when twelve experienced front-end loader operators drove the same front-end loader with three different tire conditions, 1) stock rubber tires, 2) stock rubber tires with ladder traction chains, and 3) stock rubber tires with basket traction chains. The test route included a segment of driving on paved city streets, a plowing simulation work task, and a snow dump manipulation work task all conducted in the remote city of Valdez, Alaska. The route was designed with input from the operators to simulate a typical day of exposures faced by snow removal loader operators. A tri-axial seat pad accelerometer was mounted on the operator's seat and a second tri-axial accelerometer was securely mounted on the floor of the loader directly adjacent to the seat. A WBV data acquisition system was used to collect raw (raw (+) peak, raw (-) peak, Dk, Sed)

and time weighted average (Aw, VDV, TWA peak) tri-axial WBV measurements at the seat and floor. **Results:** When comparing tire conditions, there were significant differences in WBV exposures with the ladder style chains producing the highest WBV exposures as compared to the stock rubber tire or basket chain conditions. **Conclusions:** Long-term WBV exposure has been linked to occupationally-related low back pain. When selecting traction devices for front-end loaders it is important that employers consider the associated WBV exposure differences between different types of chains. The results of this study indicate that ladder style chains have significantly higher WBV exposures than basket style chains

PO 102-4
An Analysis of the Clearance Between Electric Utility Fleet Vehicle Pedals and Adjacent Structures for Worker Anthropometry and Safe Driving Conditions

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Electric utility fleet vehicles such as pickups, vans and aerial bucket trucks have been found to provide inadequate clearance for workers wearing large boots at the accelerator pedal, brake pedal and adjacent structures such as the instrument panel and transmission hump. **Objectives:** were to determine safe clearance in the foot pedal area and then to establish the extent to which a large number of current utility fleet vehicles provide adequate clearance for the electric utility workforce. **Methods:** Three sets of measurements were collected: 1) detailed dimensions of the cabs of 16 common utility fleet vehicles 2) functional anthropometric dimensions of 187 male electric utility field and generating station employees, including boot sizes and 3) work boots, snow shoes, and rain slicker width, length and height. **Results:** obtained demonstrated that many current fleet utility vehicles lack sufficient foot clearance between the pedals and adjacent structures. This creates a number of hazardous driving conditions. **Conclusions:** included providing the funding utilities with specifications for vehicle selection, and applying this approach to other vehicle types in order to provide vehicles that meet the end users' needs and prevent unsafe conditions such as "unintended acceleration."

PO 102-5
A Radiologic Study of Correlation between Lumbar Spine Geometry and Gross Anthropometry

R. Tang, R. Sesek, Auburn University, Auburn, AL.

Objective: This is a pilot study to establish a valid and accurate means to estimate lumbar intervertebral disc dimensions. **Methods:** Lumbar spine vertebral geometry data was measured using MRI data. Lumbar spine vertebrae MRI data was obtained from a participating healthcare institution. There were four geometric measurements collected at both the L4/L5 and L5/S1 vertebral levels. These measurements were intervertebral disc body depth (IDBD), intervertebral disc body width (IDBW), vertebral width (VW) and vertebral depth (VD). Gross anthropometric data was included with each MRI data record. These data included age, gender, height and weight. Hypotheses were generated and tested regarding the correlation between lumbar vertebral geometry and gross anthropometry. Statistical analyses were performed to test the hypotheses, and regression analyses were performed to generate mathematical models estimating lumbar spine vertebrae and intervertebral disc geometry. **Results:** The relationship of intervertebral disc dimensions with subjects' overall anthropometry was explored. Gender was correlated with lumbar spine vertebrae geometry. Age was correlated with the lumbar intervertebral disc area and vertebrae geometry. Height was correlated with the lumbar intervertebral disc area and vertebrae geometry. Weight was correlated with the lumbar intervertebral disc area and vertebrae geometry. **Conclusions:** The findings from this study could be useful in developing more accurate models to estimate low back injury risk for occupational health practitioners. Individual characteristics, such as gender and age can be accounted for and incorporated into our job design, job evaluation and analysis

PO 102-6
Simple Ergonomic Assessment Tools and Design Guidelines for the Oil, Gas, and Petrochemical Industries

B. McGowan, Humantech, Inc., Ann Arbor, MI.

Objective: The purpose of this research paper is to develop a simple assessment tool to identify ergonomic issues that lead to work-related musculoskeletal disorders in the oil, gas, and petrochemical industries. A secondary purpose is to provide ergonomic design guidelines to address the root cause of these issues. The need for this research is important, as current approaches are plagued by complexities that require expert involvement and considerable time resources. **Methods:** Field research was conducted to determine common injuries and ergonomic issues in the oil, gas, and petrochemical industries. A simple ergonomic assessment tool was developed. Root causes of common ergonomic issues were identified. Design guidelines were developed to address the root causes of the most common ergonomic issue. **Results:** Field research confirmed ergonomic issues that lead to work-related musculo-skeletal disorders are abundant in the oil, gas, and petrochemical industries. Analysis indicated most injuries occur to the shoulders and back. Primary ergonomic issues include excessive horizontal reaching, over head reaching, back bending, high arm forces, heavy lifting, and contact stresses. Secondary issues include static postures, prolonged sitting, vertical climbing, and vibration. Primary root causes of these ergonomic issues are valves located too high/low, excessive manual material handling of equipment, high forces required to break/seat valves, and limited access to equipment. Ergonomic design guidelines were developed, based on ergonomic principles and functional anatomy, to minimize excessive reaching (≤ 22"), minimize over head reaching (≤ 74"), optimize manual material handling heights (24" to 62"), minimize arm force requirements (direction dependent), optimize one-person lifting requirements (≤ 27 lb), reduce valve turning forces (≤ 70 lb), and improve equipment access (≥ 46"). **Conclusions:** Simple and concise ergonomic design guidelines are available to address the primary root causes of the most prevalent ergonomic issues in the oil, gas, and petrochemical industries.

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