internal traffic control plans for asphalt paving operations on freeway segments. This research consists of observations of asphalt paving operations at two freeway sites in Arizona. Internal traffic control plans are being developed for these two operations and a development guide is being prepared that outlines procedures for preparing internal traffic control plans for asphalt paving operations. While this intervention is promising to reduce injuries to highway construction workers, the actual reduction in worker injuries is unknown.

B2.3

Title: Measuring Worker Exposure to Work Zone Equipment

Author: Hammer B

NIOSH is evaluating interventions to reduce the exposure of workers on foot to injury hazards around highway construction equipment. As part of this evaluation, visual observation methods were pilot tested on an asphalt paving operation.

For the pilot test, two visual observation methods were developed to provide overlapping surveillance of worker exposure to moving construction equipment. First, video cameras were positioned at strategic angles to the worker/equipment interface. Second, field observers were stationed on both sides of the operation in close proximity to the work. These observers, who had been briefed on the equipment hazard areas, followed the operation making notes of worker exposure to hazard areas.

By using the two methods, data were obtained for four different suboperations: milling, laying geotextile fabric, paving base course asphalt, and paving finish course asphalt. These data were merged to determine the total number of exposures, the vehicle hazard area quadrant of each exposure, and the duration of the exposure.

To develop a functional system for collecting exposure data, the relative advantages and disadvantages of both methods were assessed. One disadvantage of the observers is that they miss events entirely if distracted or recording a prior event. Improvements to the data collection recording sheet may lessen distraction time, but will not eliminate it. The videotape is advantageous in that it can be used to capture missed events and/or verify those that were observed. Furthermore, exposure times are much more precisely recorded on the tapes. The disadvantage of taping is the inability for the viewer to accurately judge depth. However, this can be offset by simultaneously taping from many angles.

By making critical improvements to each of the methods and integrating them into a complete system, a valuable field collection tool for measuring worker exposure to equipment is being developed.

B2.4

Title: Tracking Worker and Equipment Positions With GPS Receivers

Author: Hendricks SA

To quantify worker exposure to hazardous areas around operating construction equipment, the National Institute for Occupational Safety and Health (NIOSH) conducted a pilot test using global positioning system (GPS) to simultaneously track the positions of several workers and pieces of construction equipment. Recent advances in GPS receivers make it possible to locate positions with unprecedented levels of accuracy with off-the-shelf technology, although some error in the position identified by GPS still exists. The pilot testing was done during a paving operation at the Pittsburgh Research Laboratory which included milling, geotextile placement, and paving of base and wearing courses. Continuous positions of workers and equipment were collected using four different GPS receiver models. Additional static and roving tests were also conducted. The accuracy of GPS position and movement estimates is a function of the capabilities and therefore, the cost of the receiver, as well as factors ranging from errors in estimating satellite orbits to interference from obstacles (e.g., buildings) near the receiver. During the pilot test, the least expensive receivers located horizontal positions with a 68% precision of 2.1 meters and a 95% precision of 4.4 meters, while the more expensive receivers located horizontal positions with a 68% precision of 0.7 meters and a 95% precision of 2.6 meters. The goal of this effort will be to estimate the probability that a worker is located within a predefined hazard area of a piece of equipment at a specific time so that overall exposure to the worker during the day can be estimated. Since strong correlation exists between the errors of GPS horizontal position estimates from two different receivers at the same point in time, errors in distance between two different GPS receivers will be less than the sum of the individual errors. Results from the pilot test indicate that the error in distance between two of the more expensive receivers has a 68% precision of 0.3 meters and a 95% precision of 1.7 meters. Results also indicate that the squared error distance can be reasonable estimated by a gamma distribution which will allow monte-carlo simulations to be conducted to estimate the probability that a worker is in the hazard area of the specified piece of equipment. Based on these results, the more expensive receivers will be used for equipment and laborers whose tasks require them to work near operating equipment while the least expensive receivers will be used for workers who are not expected to work near operating equipment (e.g. foremen, inspectors, etc.), but who may on occasion approach operating equipment.

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