A1.3

Title: Development of a Unique Fall-Prevention Guardrail System for the Construction Industry

Authors: **Bobick T**, McKenzie T, Cantis D

Introduction: During 1998–2005, an average of 154 workers were killed and 3,374 were seriously injured each year in all U.S. industries after falling from unprotected roof edges or through unguarded holes and skylights. These occurred primarily in construction. Various products are available to guard unprotected roofs, decks, or other interior surfaces. Some are used only on flat surfaces, while others are used on sloped roofs but are adjustable for just a few roof pitches.

Methods: Previous NIOSH research investigated the strength of job-built guardrails and two commercial products as perimeter guarding. A laboratory test was developed that used a weighted manikin mounted on a hinged steel frame to evaluate guardrails according to current OSHA regulations that require the top rail to support a 200-lb force.

Results: Output from the initial study is a unique patent-pending design of an adjustable roof bracket and guardrail system. Extensive laboratory tests indicated the bracket-rail assembly supported a dynamic load of 435 lbs, more than twice the OSHA requirement of 200 lbs at top rail. The NIOSH system is unique since it can be used to guard roof edges and holes, easily moved upslope where extra protection is needed, and used in the interior to guard stairwell openings or as a temporary stair handrail. The new design is adjustable for seven roof pitches, from 6/12 (27°) to 24/12 (63°, or Aframe), three of which are steeper than 45°. Discussions have been initiated with potential manufacturers to establish a partnership to produce this safety device commercially.

Conclusions: When commercially available, residential and industrial-commercial construction workers will have an all-purpose fall-prevention system. If used routinely, it has the potential of preventing dozens of deaths and hundreds of serious injuries caused by falling from heights.

A1.4

Title: Plantar Vibration Effects on Postural Balance at Elevation

Authors: **Simeonov P**, Hsiao H, Powers J, Ammons D, Amendola A, Kau T-Y

Introduction: The risk of falls from height on a construction site increases in conditions degrading workers' postural control. At elevation, workers depend heavily on sensory information from their feet to maintain balance. Recent research suggests that low levels of mechanical vibration to the feet may be beneficial for balance control. This study investigates two hypotheses: (1) sensory-enhancement–undetectable (subthreshold) mechanical vibration at the feet improves worker's balance at elevation, (2) sensory-suppression–detectable (suprathreshold) mechanical vibration degrades worker's balance.

Methods: Twelve construction workers were tested while standing in different postures on instrumented insoles, which applied subsensory and suprasensory levels of random mechanical vibration to the feet. The tests were conducted in a virtual reality system simulating balance-challenging construction environment—i.e., a narrow plank on a residential structure. Upper body kinematics was assessed with a motion-measurement system. Postural stability effects were evaluated by conventional, "random walk," and angular-displacement sway measures.

Results: The analysis did not confirm the "sensory-enhancement" hypothesis, but provided evidence for the "sensory-suppression" hypothesis. The results indicated that plantar-vibration effects were significantly modified by posture. Subsensory vibration slightly reduced some sway measures in the standard posture but significantly increased them in the semitandem posture. Suprasensory vibration increased some sway measures across all conditions; however, the increase was considerably larger in the semitandem posture and affected most of the sway variables.

Conclusions: Sensory suppression associated with detectable levels of mechanical noise to the feet may increase the risk of losing balance. Workers on an elevated construction site might be at increased risk of falls if they can detect vibrations under their feet. To reduce the risk of losing balance, mechanical vibrations in the supporting structures should be minimized when performing tasks at elevation.