

Update on Body Shape and Size Quantification and Fall Arrest Harness Design Research

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Occupational fall-related fatalities and injuries represent serious causes of suffering and losses in the construction industry; approximately 21,000 fall-related lost-time injuries and 370 fall fatalities occur annually in construction. Fall-arrest harnesses provide the last line of defense to the 6.3-million construction workers who might be at risk for falls. Last year's two winning papers on quantifying human torso-shape and harness fit provided both scientific theories and practical production information to advance harness design and sizing for protecting construction workers from fall injuries. In addition, study methods on human body shape and size quantification developed through this research pave a way for many occupational safety applications, especially in personal protective apparatus enhancement and work space design.

NIOSH has concluded the fall arrest harness research addressing diverse worker populations through a series of four studies. The studies addressed worker-harness interfaces for fall-arrest-harness design and production that used the most current 3-D whole-body digital scanning technology. The major impacts of the research to the occupational safety community include (1) the development of innovative 3-D procedures to quantify human torso-shape effect on harness fit during protected suspensions, (2) the establishment of scientific bases for the design of gender-specific harnesses, (3) the formulation of improved harness sizing systems that accommodate diverse populations in the current workforce, and (4) the determination of harness strap lengths for manufacturing production runs. This research helps reduce the risk of worker injury resulting from poor fit, improper size selection, or the failure to don the harness properly.

The results of NIOSH harness sizing research have been adopted by manufacturers for new lines of effective fall protection harnesses for diverse populations that facilitate user productivity and ensure user comfort. A recent white paper published by MSA Fall Protection, Inc. indicated that the company has used NIOSH research findings to develop next-generation fall-arrest harnesses. Another harness manufacturer and research partner, DBI-SALA, is also using our findings to formulate product designs. In September 2010, the Canadian Occupational Health and Safety magazine (Toronto) published the findings of our sizing research and reported positive public responses regarding the practice of implementing sizing research results into harness design. Our

research findings also have been presented to the ANSI Z359 standard committee for discussion related to updating current fall protection standards; possible applications are development of anthropometrically correct torso or body manikins for harness fit and dropping tests, establishment of performance based criteria on harness sizing and configuration, and harness configuration suggestions for suspension trauma control.

The NIOSH research team is currently analyzing the effect of body and harness characteristics on suspension tolerance time and impact force on the neck after a successfully arrested fall. Fall victims may suffer suspension trauma (fatal reduction of return blood flow from the legs to the heart and brain) after a successfully arrested fall, if they are not rescued quickly or the harness does fit them well. Fall victims also are exposed to the risk of neck injuries during a forceful suspension; using an instrumented manikin, NIOSH can address this issue. These are critical companion studies to provide integrated fall protection to the workforce at risk for falls during their daily work.

It is also worth noting that our research findings have inspired several international organizations to explore revolutionary approaches to study how human body shape and dimensions interact with protective equipment, including fall-arrest harness configurations, to affect safe harness design and use, respirator test panel design, and sizing determination of protective clothing. NIOSH also is studying national truck driver anthropometric measurements to develop digital human avatars for next-generation truck cab and seat design as well as firefighter anthropometry to develop improved fire-engine cabs, seats, restraint systems, egress, and bunker gear.