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Wood Dust and Nanoparticle Exposure among Workers during a New Building Construction

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Abstract : Building constructions in the US involve numerous wooden structures. Woods are routinely used in walls, framing floors, framing stairs, and making of landings in building constructions. Cross-laminated timbers are currently being used as construction materials for tall buildings. Numerous workers are involved in these timber based constructions, and wood dust is one of the most common occupational exposures for them. Wood dust is a complex substance composed of cellulose, polyoses and other substances. According to US OSHA, exposure to wood dust is associated with a variety of adverse health effects among workers, including dermatitis, allergic respiratory effects, mucosal and nonallergic respiratory effects, and cancers. The amount and size of particles released as wood dust differ according to the operations performed on woods. For example, shattering of wood during sanding operations produces finer particles than does chipping in sawing and milling industries. To our knowledge, how shattering, cutting and sanding of woods and wood slabs during new building construction release fine particles and nanoparticles are largely unknown. General belief is that the dust generated during timber cutting and sanding tasks are mostly large particles. Consequently, little attention has been given to the generated submicron ultrafine and nanoparticles and their exposure levels. These data are, however, critically important because recent laboratory studies have demonstrated cytotoxicity of nanoparticles on lung epithelial cells. The above-described knowledge gaps were addressed in this study by a novel newly developed nanoparticle monitor and conventional particle counters. This study was conducted in a large new building construction site in southern Georgia primarily during the framing of wooden side walls, inner partition walls, and landings. Exposure levels of nanoparticles (n = 10) were measured by a newly developed nanoparticle counter (TSI NanoScan SMPS Model 3910) at four different distances (5, 10, 15, and 30 m) from the work location. Other airborne particles (number of particles/m3) including PM2.5 and PM10 were monitored using a 6-channel (0.3, 0.5, 1.0, 2.5, 5.0 and 10 µm) particle counter at 15 m, 30 m, and 75 m distances at both upwind and downwind directions. Mass concentration of PM2.5 and PM10 (µg/m³) were measured by using a DustTrak Aerosol Monitor. Temperature and relative humidity levels were recorded. Wind velocity was measured by a hot wire anemometer. Concentration ranges of nanoparticles of 13 particle sizes were: 11.5 nm: 221 – 816/cm³; 15.4 nm: 696 – 1735/cm³; 20.5 nm: 879 – 1957/cm³; 27.4 nm: 1164 – 2903/cm³; 36.5 nm: 1138 – 2640/cm³; 48.7 nm: 938 – 1650/cm³; 64.9 nm: 759 – 1284/cm³; 86.6 nm: 705 – 1019/cm³; 115.5 nm: 494 – 1031/cm³; 154 nm: 417 – 806/cm³; 205.4 nm: 240 – 471/cm³; 273.8 nm: 45 – 92/cm³; and 365.2 nm: <LOD – 58/cm³. Average concentration (No/m³) ranges for the particles of 0.3, 0.5, 1.0, 2.5, 5.0 and 10 µm sizes were: Upwind – 13,736 – 31,065; 2,706 – 12,872; 568 – 2,756; 99 – 658; 14 – 192; 8 – 110; Downwind – 12,129 – 12,449; 3,929 – 4,160; 601 – 1,049; 18 - 52; 8 – 36. Collected preliminary data indicated that workers were exposed to not only coarse wood dust particles but also very high levels of nanoparticles.

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