

Exposure Assessment for Worker Exposed to Heavy Metals during Road Marking Operations

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Abstract : The present study was conducted to characterize exposure concentrations, concentrations deposited on the different respiratory regions, and resultant health risks associated with heavy metal exposures for road marking workers. Road marking workers of three similar exposure groups (SEGs) were selected, including the paint pouring worker, marking worker, and preparing worker. Personal exposure samples were collected using an inhalable dust sampler (IOM), and the involved particle size distribution samples were estimated using an eight-stage Marple personal cascade impactor during five working days. In total, 25 IOM samples and 20 Marple samples were collected. All collected samples were analyzed for their heavy metal contents using the ICP/MS. The resultant heavy metal particle size distributions were also used to estimate the fractions of particle deposited on the head airways (Chead), tracheobronchial (Cthorac) and alveolar regions (Cresp) of the exposed workers. In addition, Pb and Cr were selected to estimate the incremental cancer risk, and Zn, Ti, and Mo were selected to estimate the corresponding non-cancer risk in the present study. Results show that three heavy metals, including Pb, Cr, and Ti, were found with the highest concentrations for the SEG of the paint pouring worker ($=0.585\pm 2.98$, 0.307 ± 1.71 , 0.902 ± 2.99 $\mu\text{g}/\text{m}^3$, respectively). For the fraction of heavy metal particle deposited on the respiratory tract, both alveolar and head regions were found with the highest values ($=23\text{-}43\%$ and $39\text{-}61\%$, respectively). For both SEGs of the paint pouring and marking, 51% of Cr, 59-61% of Zn, and 48-51% of Ti were found to be deposited on the alveolar region, and 41-43% of Pb was deposited on the head region. Finally, the incremental cancer risk for the SEGs of the paint pouring, marking, and preparing were found as 1.08×10^{-5} , 2.78×10^{-6} , and 2.20×10^{-6} , respectively. In addition, the estimated non-cancer risk for the above three SEGs was found to be consistently less than unity. In conclusion, though the estimated non-cancer risk was less than unity, all resultant incremental cancer risk was greater than 10^{-6} indicating the abatement of workers' exposure is necessary. It is suggested that strategies, including placing on the molten kettle, substitution the currently used paints for less heavy metal containing paints, and wearing fume protecting personal protective equipment can be considered in the future from reducing the worker's exposure aspect.

Keywords : health risk assessment, heavy metal, respiratory track deposition, road marking

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