Benzene exposure to workers during tunnelling - using biological monitoring to assess control measures and working practice.
The Problem

A main tunnel was under construction, as part of upgrades to the Belfast wastewater and sewers infrastructure, on the site of a former gas works. Soil samples had indicated the presence of various volatile organic chemicals, including benzene. Initial monitoring (using both air and biological sampling) showed that benzene exposure was being well controlled, however, benzene levels began to rise rapidly; well in excess of the UK workplace exposure limit. This corresponded with a rise in temperature (early May) and workers were complaining about the heat and were sweating profusely inside their suits. A small number of workers exhibited signs of what was believed to be heat stress/dehydration.

What we did

We measured a specific metabolite of benzene called S-phenyl mercapturic acid (SPMA) in urine samples from exposed workers. A guidance value (equivalent to an 8-hour exposure at the workplace exposure limit) allowed us to interpret the results.

In response to the high temperatures, workers had been provided with additional bottled water. However, the subsequent series of biological monitoring results showed significant benzene exposure with 20% of samples exceeding the guidance value for urinary SPMA; in the worst case by over 10 fold. On investigation, it was found that due to the heat and the need to drink water more frequently, workers had been removing their PPE in the tunnel during work, when leaving the tunnel at break times, and at the end of their shifts. Some also reported taking off their respirators to answer their mobile phones.

A decision was taken to stop working and during this time a chiller was installed to improve working comfort. PPE was upgraded and changes were made to working practice.

Work resumed with at least weekly biological monitoring. Prompt analysis and reporting of the results allowed site management to quickly intervene if biological monitoring indicated a failure of control. Following these improvements, a dramatic reduction in SPMA levels was seen, with only three results out of 432 (0.7%) subsequently exceeding the guidance value.

Outcome/Benefits

This case study illustrates the value of biological monitoring in situations where control of exposure primarily relies on RPE and other PPE. Although air monitoring had identified ‘hot spots’ of contamination, the intermittent nature of these pockets of benzene contamination and the extensive use of PPE meant that it was not sufficient to assess the risk of exposure. Biological monitoring was able to give an integrated measurement of actual systemic exposure (despite the PPE) and highlight issues with both the PPE and its use. Furthermore, since biological samples are specific to an individual, it enabled the identification of any human factors that might influence exposure control.

The improvements to control measures and working practice, in light of the elevated biological monitoring results, resulted in significant reductions in worker exposure to benzene. Thus biological monitoring enabled the job to be completed whilst giving assurance that the workforce was not being exposed to potentially hazardous levels of benzene.