

Protecting workers from Diesel Engine Exhaust Emissions (DEEE) in tunnel working

J. Murphy & Sons Limited case study

Diesel engines are in widespread use in the railway industry – most obviously as diesel traction but other sources such as diesel generators and diesel-powered equipment are commonly used in depots and at maintenance/renewal worksites, especially in tunnels.

Diesel engine exhaust emissions (DEEE) are recognised as a category 1 human carcinogen (“definite”) by the International Agency for Research in Cancer (IARC) for lung cancer. Recent HSE cancer burden research estimates that there are almost 650 deaths per year from all workplace exposures to DEEE in the United Kingdom.

In planning for the construction of a new railway tunnel at Farnworth, J. Murphy & Sons Limited (Murphy) wanted the project to focus on protecting the health of the personnel both long term and short term, as well as their safety, during the work.

Murphy was conscious of recent data and analysis on deaths of construction workers that had been attributed to exposures to silica, asbestos and DEEE, as well as health issues associated with exposure to high levels of noise, musculoskeletal disorders (MSDs) and hand arm vibration syndrome (HAVS).



To specifically reduce exposure to DEEE, Murphy:

- held open briefings with all personnel focusing on all identified potential health risks and how they would all work together as a team to mitigate and control these risks to health. Many workers on site did not realise the potential threat to their health from diesel fumes exposure, so Murphy went over and beyond the usual 'tool box talks'.
- to reduce DEEE emissions we removed red diesel from all plant operating in the tunnel, instead replacing it with premium diesel fuel. Based on our experience and analysis of petrochemical data, we considered that premium diesel provided optimum efficiency for the type and size of plant operating in this environment. Ultra-low sulphur diesel (USLD) has a lower energy content, which would have increased fuel consumption and decreased efficiency of the plant, with potential to increase DEEE emissions.
- planned and constructed a 350mm twin wall pipe within the crown of the tunnel prior to filling it with foam concrete. This allowed air to be extracted from the opposite end of the tunnel as air was forced in from the open face, providing a positive flow of air within the tunnel. We had never incorporated such an air flow system within a tunnel construction before and it ensured fumes and dust particles were effectively removed.
- RVT Group supplied a VENTEX FA800CF steel mobile 800mm 415v 63a centrifugal fan, with an airflow rating of 51,000 m³/hour free air. This fan design was provided high volumes of ventilation over long duct runs, i.e. for tunnels and deep basements, due to the high pressure developed.
- we followed engineering best practice standards for air flow within tunnels and shafts, as detailed in BS 6164. We measured the rate of air removal, which was an average of 1m³ per second. The air flow figure was calculated by the RVT Group's technical support. This was done by gaining access to the tunnel face and taking air flow readings and calculations using specific air monitoring equipment. This was a one off monitoring assessment carried out during a period of down-time for planned maintenance of the tunnel boring machine (TBM).
- we ensured all plant entering the tunnel as part of the construction process had particulate filters fitted to their exhausts to absorb air-borne particulates produced by diesel engines. This included three 30-tonne articulated haulers (Moxis), a flatbed wagon and a tele-handler. We used a proprietary fume control system, which operated on a flow-through filter arrangement, instead of a heat exchange process.
- we installed a proprietary tunnel atmosphere monitoring system in the tally hut on site, with sensors set within the TBM. This was set to detect low levels of oxygen and potential build-up of explosive gases such as methane. In line with best practice for enclosed spaces where diesel plant is operating, it was also set to detect nitrogen dioxide build-up within the tunnel. In the absence of a mandatory workplace exposure limit for nitrogen dioxide, we used a guidance level of 3ppm eight-hour time weighted average.

- Our efforts to 'engineer out' the risks, and the systems of control and monitoring we put in place, removed the need for personnel to use respiratory protective equipment (RPE). The effectiveness of the monitoring and controls was clear. Diesel fumes did not accumulate within the crown of the tunnel and workers did not suffer from irritation to the eyes, coughing or tiredness.