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Firefighters are occupationally exposed to a large number of toxic compounds (IARC 2010). The occupational exposure of firefighters has been classified as potentially carcinogenic (class 2B, IARC; (Straif K. et al. 2007)). Poorly quantified emission factors and low understanding of when various aerosol emissions are likely to form during a fire event (initiation, combustion, extinguishing) inhibit efforts to reduce exposure by interventions to the firefighting strategy.

The study was designed to evaluate firefighters' exposure to air pollutants and to allow identification of how aerosol emissions respond to burning conditions and interventions of the firefighting. The study was conducted at the MSB firefighter training facility in Revinge outside Lund, Sweden. Eight small (5x3x2 m) sheds were built to imitate small compartment environments: apartment, bedroom, workshop, etc. These sheds were ignited under realistic fire scenarios (e.g., accident, arson) and later used for training new fire investigators (forensic police). Firefighter students and teachers monitored and extinguished the fires in similar procedures to real fire events. A supervisor monitored the combustion conditions, allowing or restricting fresh-air flow into the fire by opening or closing of the main door.

Fire emissions were extracted from the fire through a 10 m (Ø 6 mm) stainless steel pipe, diluted ~1:50 with HEPA and active charcoal filtered air. The diluted emissions were monitored with a battery of aerosol monitoring instruments. Instrumentation included an aerosol mass spectrometer (Aerodyne SP-AMS, Billerica USA), an aethalometer (AE33, Magee Sci. USA), a differential mobility spectrometer (DMS500, Cambustion, UK), CO_2 monitor (LI-COR, USA), and a NO/NO_2 monitor (2BTech, USA). Complementary background measurements were positioned downwind or sidewind of the fires. With this equipment we collected data with the aim to resolve relationships between combustion conditions and pollution formation during different phases of a fire response.

The results showed that total particle mass (PM1) emissions correlated with CO_2 emissions and thus fire intensity. The emissions were speciated according to equivalent black carbon (eBC), organic aerosol (OA) and polycyclic aromatic hydrocarbon (PAH) derived from AMS data. When speciated, different particle emissions were found to depend on activities of the firefighting and the supervisor responsible for allowing or restricting fresh air into the combustion environment. Most evidently, we found that restricting the access to O_2 by closing the door resulted in a sharp increase of OA and even more pronounced, PAH. PAH increased by several orders of magnitude, suggesting that PAH exposure-risks may increase drastically when fires become under-ventilated. Extinguishing the fire with water quickly decreased all particle emissions. The results described are illustrated in Figure 1.

Further analysis involves additional off-line analyses, derivation of emission factors, time-resolved speciated emission analysis and evaluation of relationships between emissions, burning conditions and firefighting strategies.

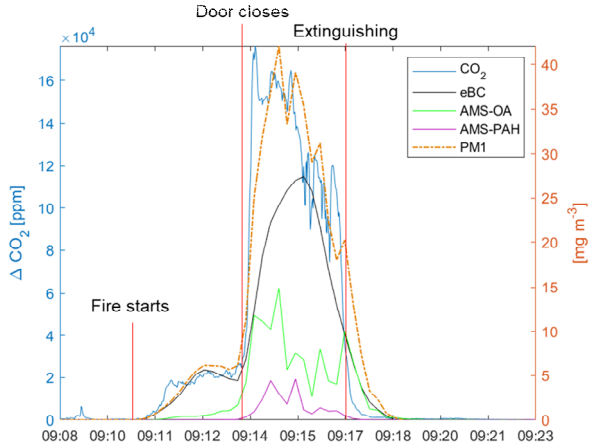

Figure 1. Time-resolved emissions after 1:65 dilution of net carbon dioxide ΔCO_2, equivalent black carbon (eBC), AMS organic aerosol (OA), AMS polycyclic aromatic hydrocarbon (PAH) and total particle mass (PM1).

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IARC. 2010. *Painting, Firefighting and Shiftwork*. Lyon, France: IARC Monographs on the Evaluation of Carcinogenic Risks to Humans Volume 98. WHO, International Agency for Research on Cancer.

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