

## HPS Briefing Note on Products of Combustion

### Toxins in Fire Smoke (also available via SHPIR website)

The principal products of efficient combustion of organic material are water vapour and carbon dioxide. However, toxic and noxious chemicals may be produced during incomplete or inefficient combustion. In general, the less efficient the combustion, the more toxins are produced.

Substances of concern in the smoke derived from organic material combustion (e.g. oil and fuels) are:

- Carbon monoxide (CO);
- Formaldehyde;
- Respirable particulates;
- Acrolein.

#### Carbon Monoxide

CO is an odourless, colourless gas - people may be unaware of overexposure.

CO affects the body by reducing the oxygen carrying capacity of the blood.

Initial exposure symptoms include headache, nausea, dizziness and weakness, followed in severe cases by loss of time awareness, motor skills and mental acuity.

It can take up to 72 hours to purge CO from the body.

The risk of overexposure to CO is significantly greater in smokers, who already have a significant background level of carboxyhaemoglobin in their blood.

CO also presents a greater potential hazard to pregnant women. Foetal blood levels of CO may be 10-15% higher than maternal levels.

#### Particulate Matter

Over 90% of particulates produced in fire smoke are respirable.

Studies have shown a correlation between number of hospitalisations for respiratory problems and pollution events of high concentrations of fine particulates.

The remaining 10% precipitate from the air or are filtered by the nose or mouth. Particulates serve as vectors of carcinogens (such as polynuclear aromatic hydrocarbons) and other toxic compounds.

Overexposure causes **irritation of mucous membranes** and a **decrease in lung capacity and function** over time.

### **Formaldehyde**

Formaldehyde is an aldehyde that is produced during combustion of cellulose based materials e.g. wood, cotton, paper and some plastics. The odour of this toxin is detectable at very low concentrations (about 1ppm).

Low-level exposure causes **irritation of eyes, stuffy nose** and **sore throat**. Higher levels cause irritation to spread to the lower respiratory tract.

Long-term exposure of formaldehyde may cause nasal cancer.

### **Acrolein**

Acrolein is produced during the combustion of cellulose based material e.g. wood, cotton, paper. Acrolein is an aldehyde that has a piercing, choking odour, even at very low concentrations.

Low-level exposure causes **severe irritation of eyes** and **upper respiratory tract**, producing **stinging** and **tearing of eyes, nausea**, and **vomiting**.

Higher concentrations have been measured in white smoke, as opposed to emissions from glowing combustion.

### **Combined Effects**

Particulates, formaldehyde and acrolein all act as respiratory irritants; therefore their combined effects must be considered when judging exposure. Tolerance levels may also be lower when exposed at high elevations or higher air temperatures. The involvement of additional materials in a fire (e.g. metals, plastics, resins, and solvents) may result in the evolution of other hazardous combustions by-products such as hydrogen cyanide (HCN), hydrogen chloride (HCl), polycyclic aromatic hydrocarbon (PAHs), nitric oxide and nitrogen dioxide (NO<sub>x</sub>), sulphur oxides (SO<sub>x</sub>), and dioxins.