Live Fire Training Instructors

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Live fire training instructors (trainers) are a high-exposure group within the fire service and are a particular focus of the FFCCS Expansion grant. This article is intended to provide summary background information on trainer exposures and health effects, as well as ongoing FFCCS research on trainer exposures, resulting health effects, and recommended actions.

Trainer exposures

Firefighter trainers have high levels of exposure to chemical carcinogens in the products of combustion (Kirk and Logan, 2015), exceeding those of trainees due to the increased frequency and duration of exposure from multiple training sessions (Fent et al., 2019).

Exposures by fuel packages

Among live-fire training scenarios, in general, the highest exposures are associated with the use of engineered wood products bonded with synthetic resins (oriented strand board (OSB), plywood, particle board, etc.), followed by natural wood and straw, with the lowest exposures associated with use of propane.

In a 2010 study directly comparing fuel packages, Dr. Laitinen and co-authors showed that the highest exposures to trainers occurred with combustion of conifer plywood and chipboard, lower exposures occurred with natural pine and spruce wood, and the lowest exposures with propane. Urinary levels of 1-pyrenol (a metabolite of pyrene, a polycyclic aromatic hydrocarbon (PAH)), benzene (a known human carcinogen associated with leukemia) emissions and hydrogen cyanide emissions averaged 4.3–9.2 nmol/L, 1.0–2.5 mg/m^3 and 0.2–0.9 mg/m^3 respectively with plywood and chipboard, 1.5 nmol/L, 0.6 mg/m^3, and 0.05 mg/m^3 respectively with pure pine and spruce wood, and 1.0 nmol/L, 0.2 mg/m^3, and below detectable limits respectively with propane.

In a 2019 study, Dr. Fent and co-authors compared exposures from different live-fire training scenarios and fuel packages. Urinary PAH metabolites were the highest for the training scenarios using OSB in a metal prop and the lowest for training scenarios using pallets and straw in a concrete training structure. Furthermore, a single day for trainers with three OSB exercises led to a 30-fold increase in 1-pyrenol, as trainers accumulated exposure with each daily exercise. For trainers combining all urinary PAH metabolites after three daily exercises, exposures were at least 80-100% higher with OSB as compared with pallets and straw. Measuring exhaled breath benzene, exposures for firefighters after a single exercise were approximately two to six-fold higher for OSB compared with pallets and straw. Although there were differences in exposures based on the type of OSB used, all OSB training scenarios were associated with higher exposures than scenarios burning pallets and straw. The results presented in this paper do not support the assertion that the use of a particular brand of OSB results in exposures of similar magnitude to burning pallets and straw nor did this study evaluate other manufactured wood products.

Health effects

Increased cancer rates have been reported in association with greater exposures among trainers (Glass et al., 2016). Of note, additional studies are needed given the small sample size in this study of fire trainers.

Ongoing trainer studies within the FFCCS

The FFCCS is currently conducting evaluations of trainers from multiple US fire departments, including but not limited to collection of urine before and after training fires to quantify exposures. Furthermore, blood collected from trainers will be compared with non-trainer firefighters for markers of cancer risk, including DNA methylation.

Recommended actions

The results of the two exposure studies described above show increased trainer exposures associated with the use of engineered wood products. While additional research on this topic is ongoing, findings published to date are sufficient to warrant preventive action to reduce exposure to chemical carcinogens[1] for both trainers and trainees. As a result, and given the precautionary principle[1], we recommend against the use of engineered wood products during live-fire training scenarios. We will continue to evaluate this as the evidence develops. When all other factors are constant in the training environment, burning propane should result in the lowest exposures with the use of natural wood products, while producing exposures above that of propane, are lower than with engineered wood products. Whenever possible, the number and duration of exposures from live fire training should be minimized.

This page will be updated as the FFCCS trainer studies described above are completed.

References

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[1] "The precautionary principle, proposed as a new guideline in environmental decision making, has four central components: taking preventive action in the face of uncertainty; shifting the burden of proof to the proponents of an activity; exploring a wide range of alternatives to possibly harmful actions; and increasing public participation in decision making." D Kriebel, J Tickner, P Epstein, et al. The precautionary principle in environmental science. Environ Health Perspect. 2001 Sep; 109(9): 871–876