



Finnish Institute of
Occupational Health

FIRE FIGHTING TRAINERS' EXPOSURE TO CARCINOGENIC AGENTS IN SMOKE DIVING SIMULATORS

Laitinen J, Mikkola J, Mäkelä M, Valkonen S and Aitio A.

Finnish Institute of Occupational Health

Ismo Huttu

Finnish Emergency Services Collage

THE AIMS OF THE STUDY

- HOW THE BURNING MATERIAL, THE TYPE OF SIMULATOR, AND PROTECTIVE EQUIPMENTS AFFECT ON SMOKE DIVERS' EXPOSURE ?



TOPICS OF THE PRESENTATION

- Description of smoke divers working condition
- Used methods in exposure assessment
- The results of the measurements
- Conclusions and recommendation



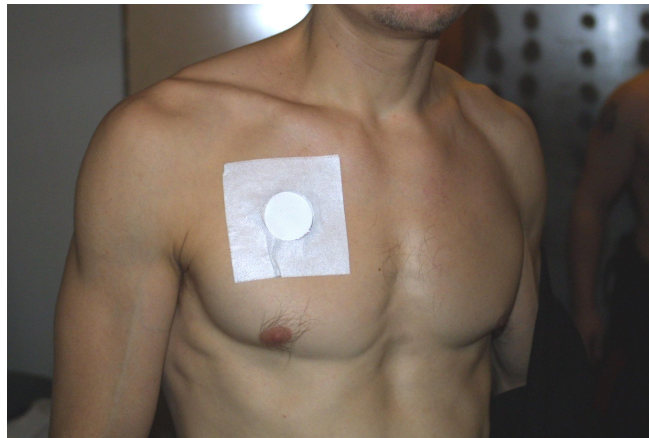
FIRE FIGHTING IN FINLAND

- Smoke diving licence have to update every year
- Updating process have to carried out in simulators in Emergency Services Collage
- Trainers have to smoke dive even 120 times per year



METHODS IN EXPOSURE ASSESSMENT

- TOTAL EXPOSURES were measured from trainers' urinary samples
 - 1-pyrenol, 1-naphtol and muconic acid
- DERMAL EXPOSURES to polycyclic aromatic hydrocarbons was measured from the surface of body (chest and back) and from the hands



- AIR CONCENTRATIONS of hydrogen cyanide, volatile organic compound and polycyclic aromatic hydrocarbons from burning material were measured from the AIR OF THE SIMULATORS during trainings

GAS-SIMULATOR

- burning material propane
- artificial smoke was generated from mineral oil
- two trainers participated in this test
- three smoke diving session for each trainer
- length of the session was 30 minutes
- fire fighter suits were made by Bristol
- trainers wore under gloves inside fire gloves
- tested trainers were non-smokers



"FIRE HOUSE" - SIMULATOR

- four trainers participated in these tests
- three smoke diving session for each trainer
- one session length was 30 minutes
- Fire fighter suits were made by Bristol and Brage
- tested trainers were non-smokers

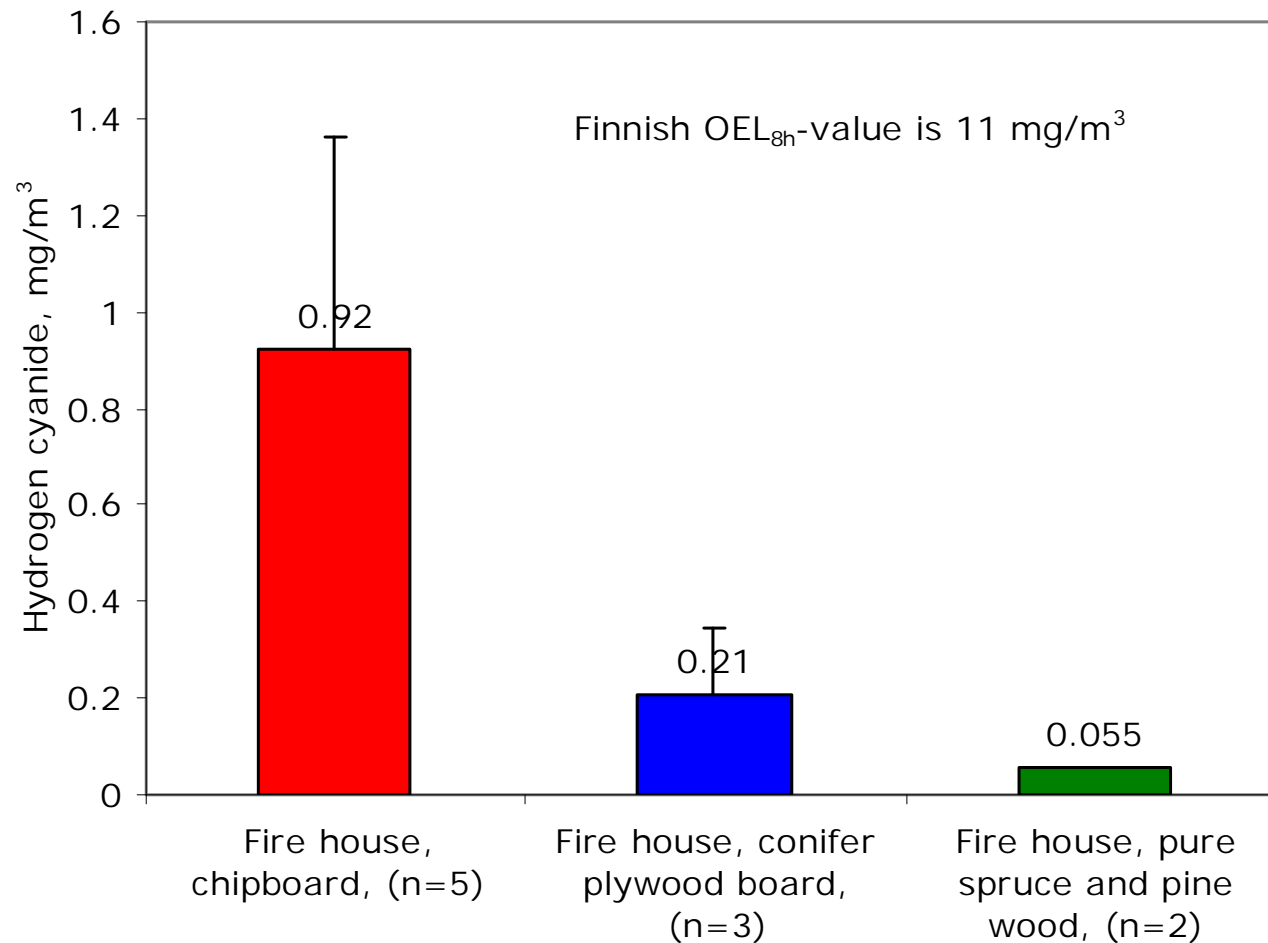


FIRE HOUSE- Materials in testing

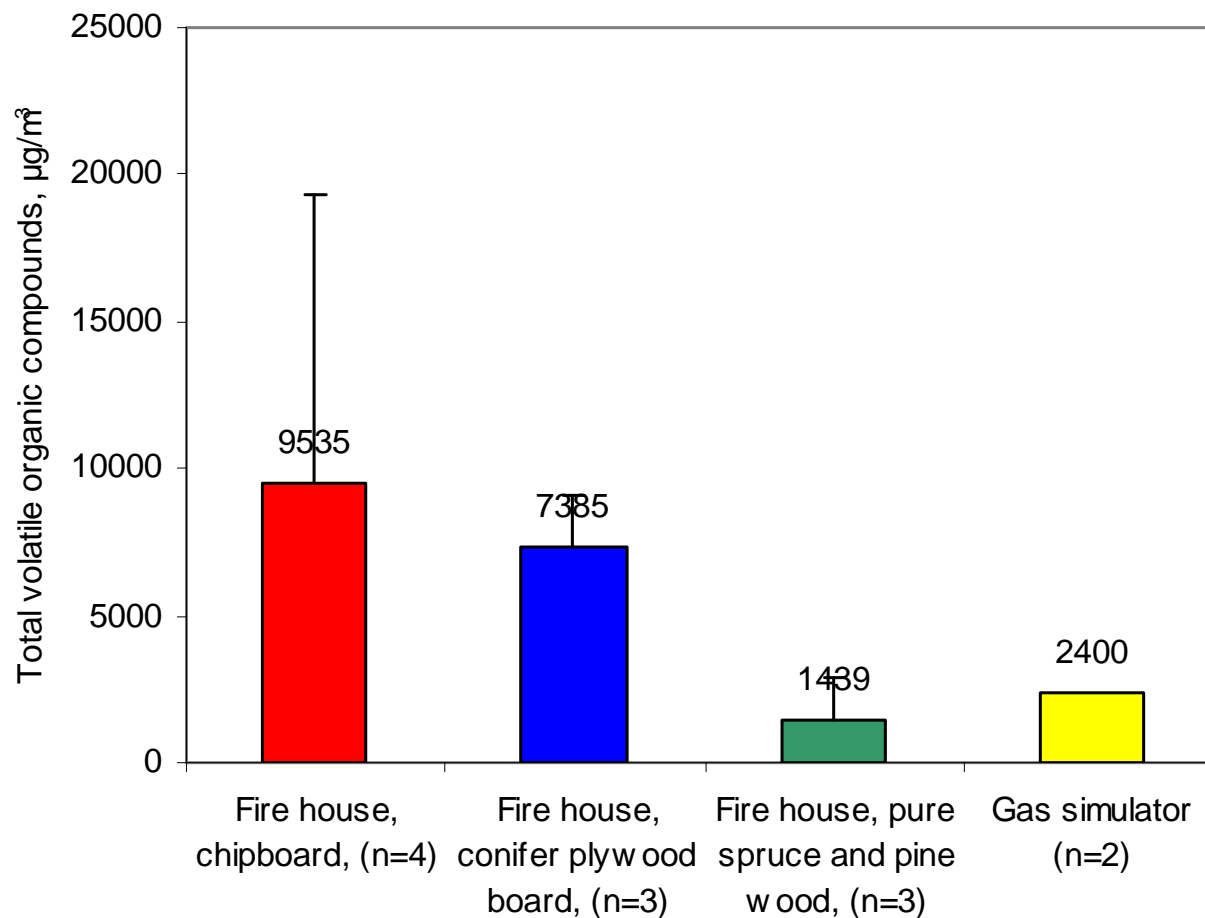
- To test burning materials affect on smoke divers' exposure
 - First test
 - chipboard for the partition walls
 - extra smoke was done by burning polystyrene foam
 - firing liquid was kerosene
 - Second test
 - conifer plywood board for the walls
 - firing liquid sinol (80 % ethanol)
 - Third test
 - pure spruce and pine wood and sinol



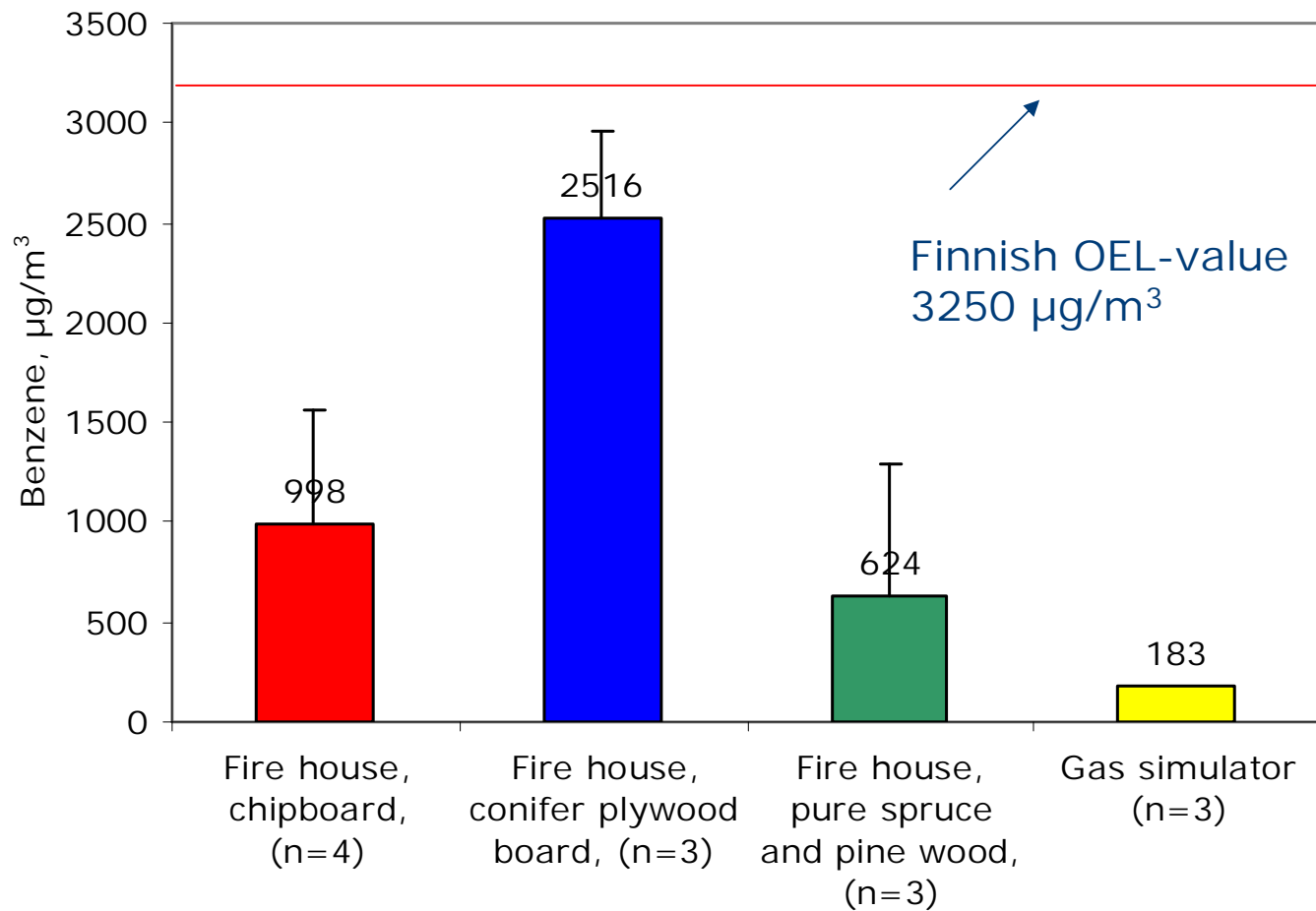
THE CONCENTRATIONS OF HYDROGEN CYANIDE IN THE AIR OF SIMULATORS USING DIFFERENT BURNING MATERIALS



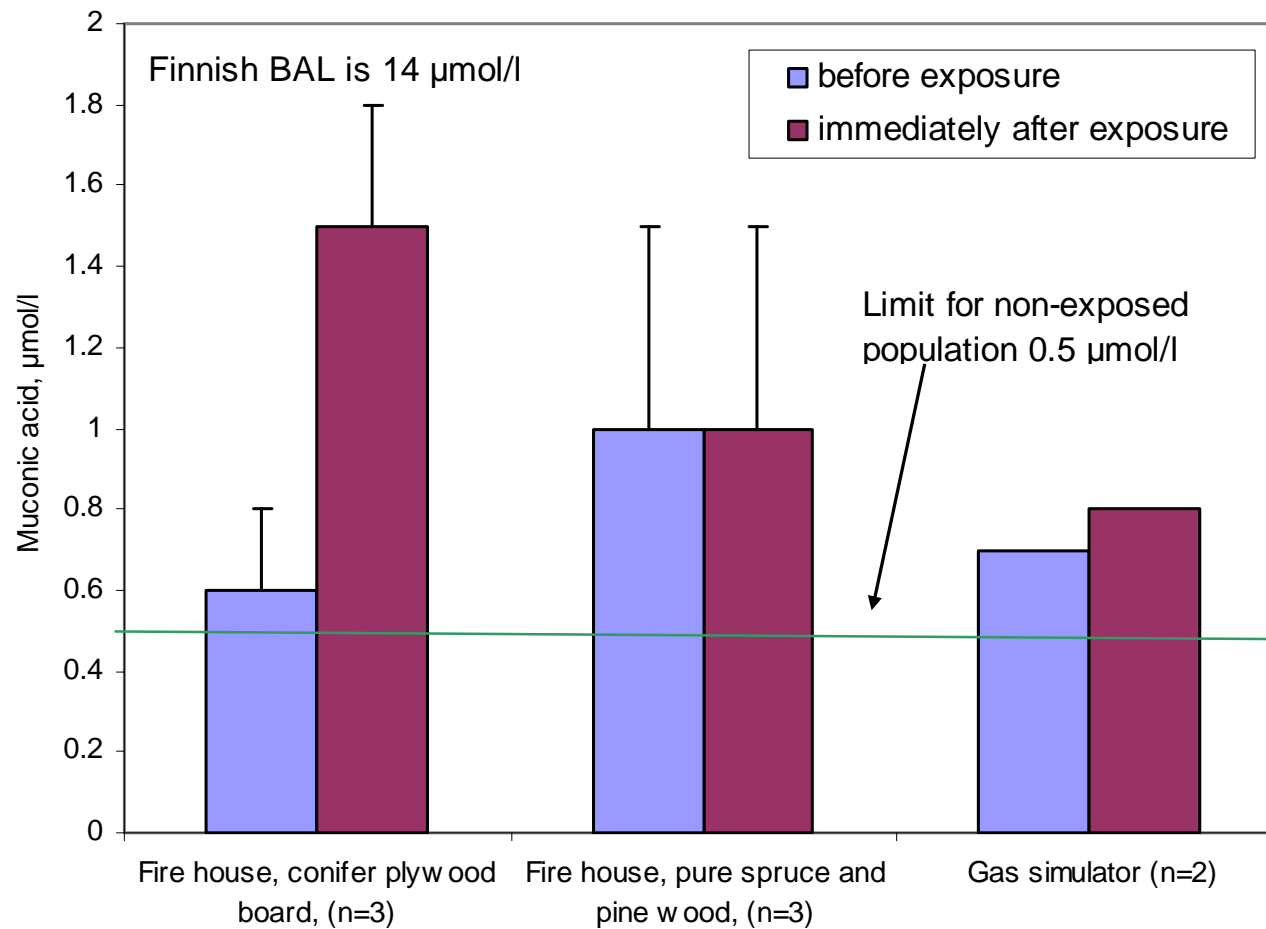
THE CONCENTRATIONS OF TOTAL VOLATILE ORGANIC COMPOUNDS IN THE AIR OF SIMULATORS USING DIFFERENT BURNING MATERIALS



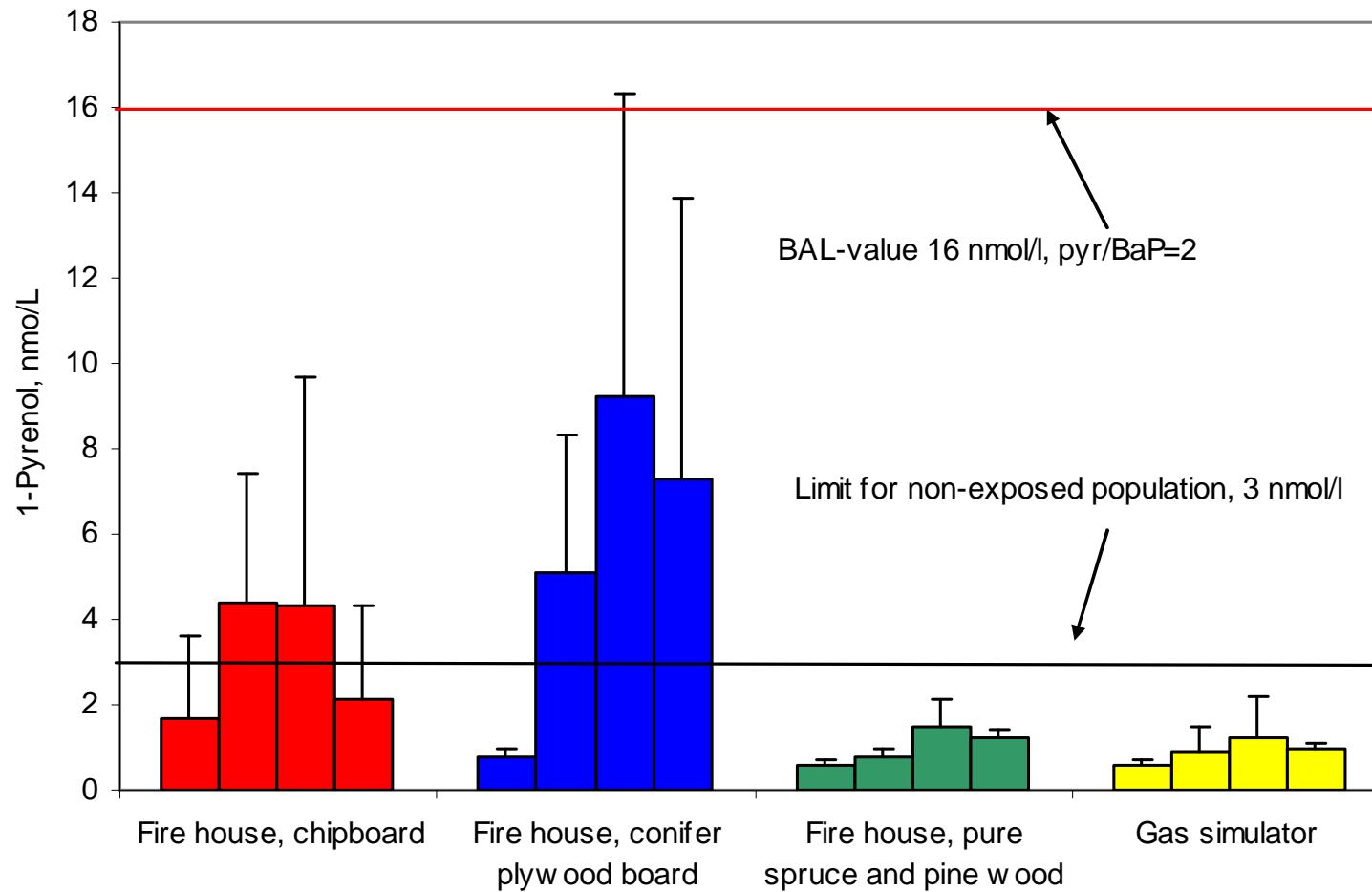
THE CONCENTRATIONS OF BENZENE IN THE AIR OF SIMULATORS USING DIFFERENT BURNING MATERIALS



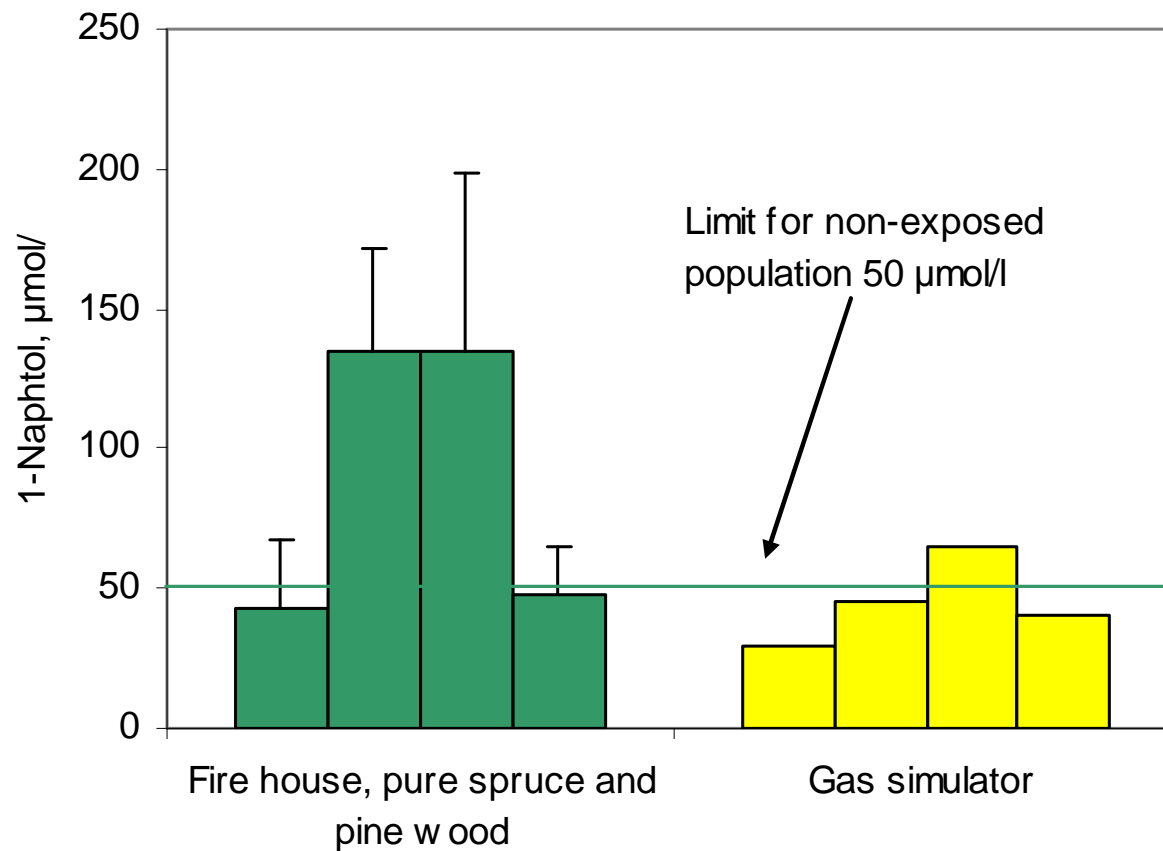
TRAINERS' AVERAGE URINARY EXCRETION OF MUCONIC ACID USING DIFFERENT BURNING MATERIALS



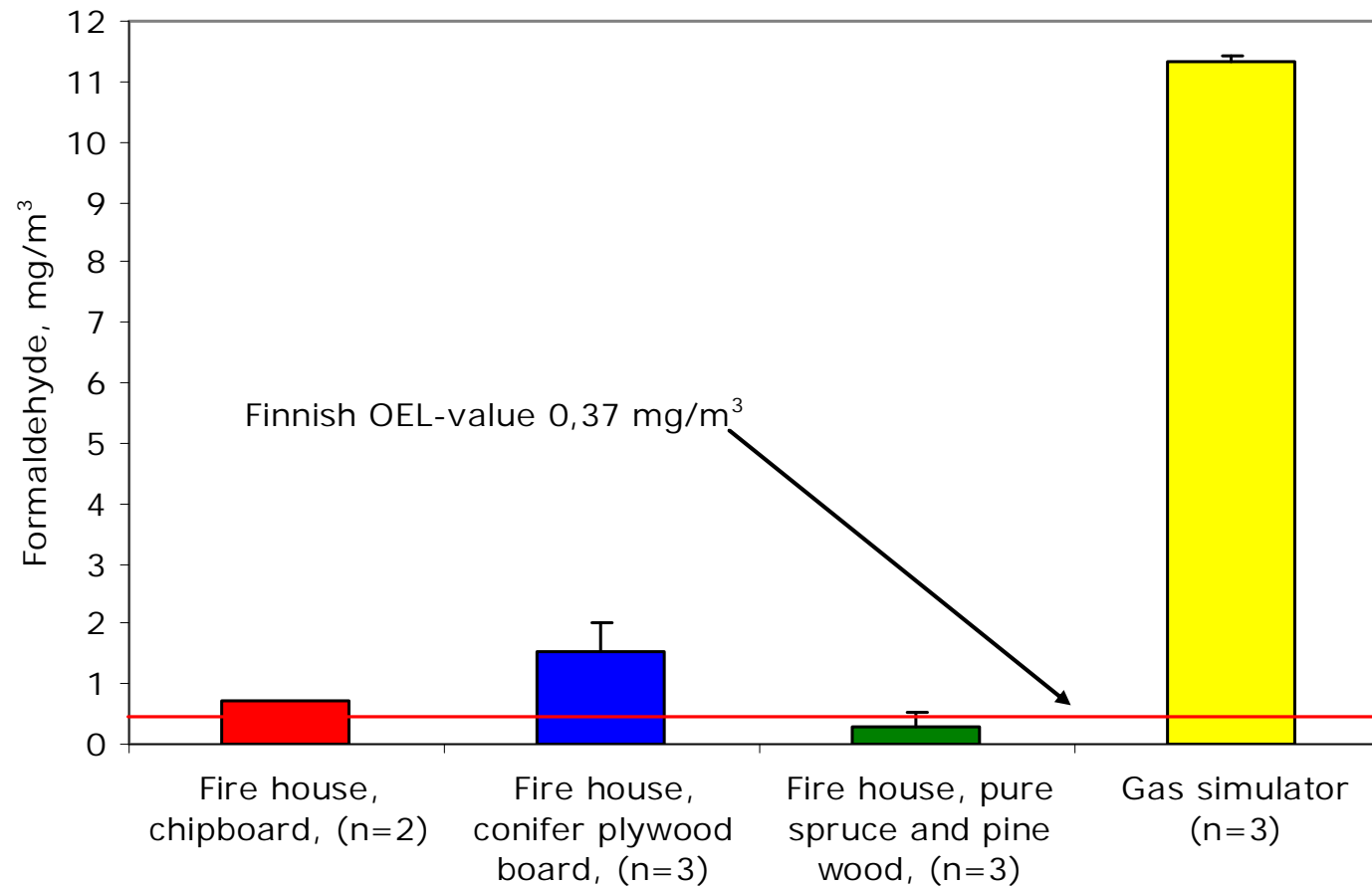
TRAINERS' AVERAGE URINARY EXCRETION OF 1-PYRENOL IN FOUR TIME POINTS USING DIFFERENT BURNING MATERIALS



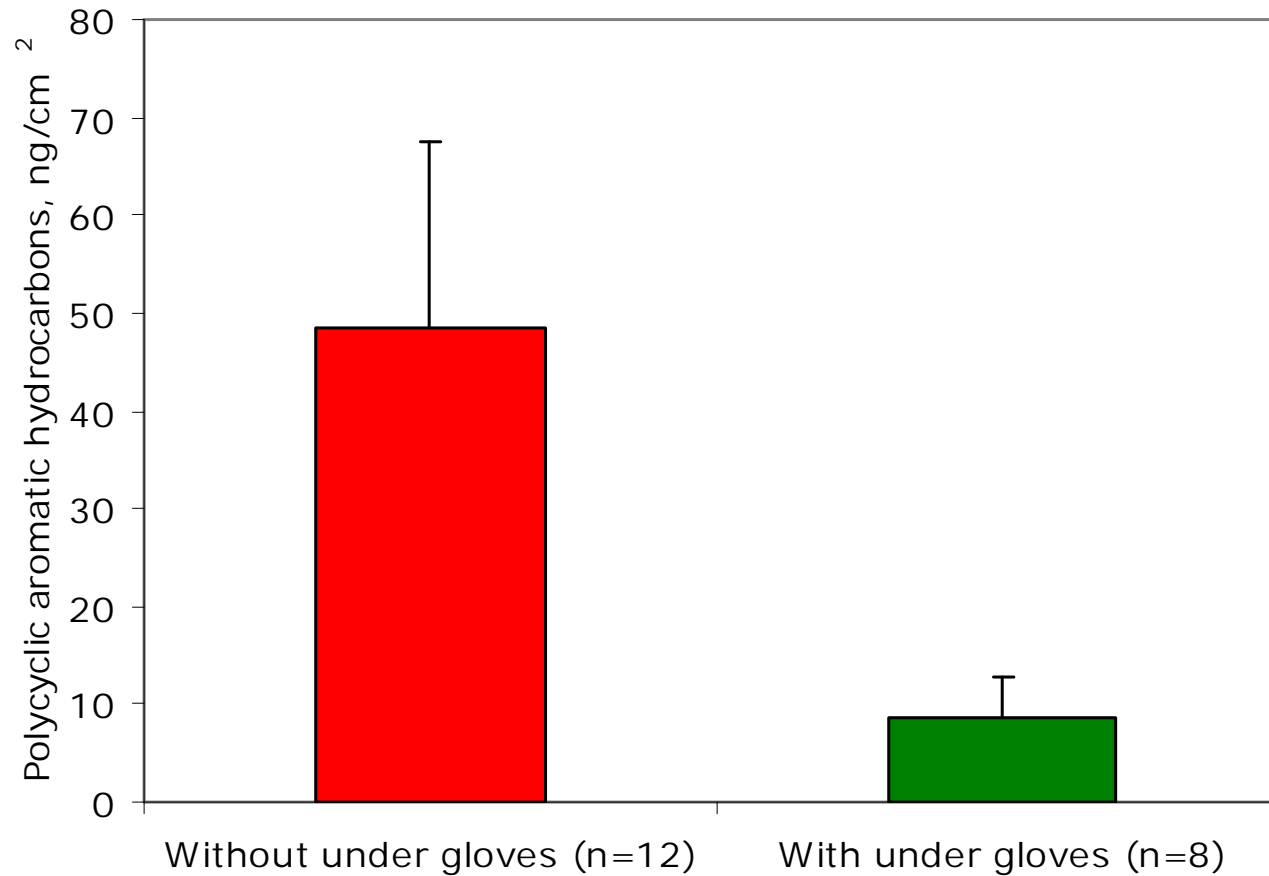
TRAINERS' URINARY EXCRETION OF 1-NAPHTOL IN FOUR TIME POINTS USING DIFFERENT BURNING MATERIALS



THE CONCENTRATION OF FORMALDEHYDE IN THE AIR OF SIMULATORS USING DIFFERENT BURNING MATERIALS



THE AMOUNT OF POLYCYCLIC AROMATIC HYDROCARBONS IN TRAINERS' HANDS AFTER TRAININGS IN FIRE HOUSE



CONTAINER- SIMULATOR

- burning material conifer plywood board and sinol
- four trainers participated in these tests
- three smoke diving session for each trainer
- length of one session was 30 minutes
- fire fighter suits were made by Bristol and Brage
- tested trainers were non-smokers
- all trainers used under gloves

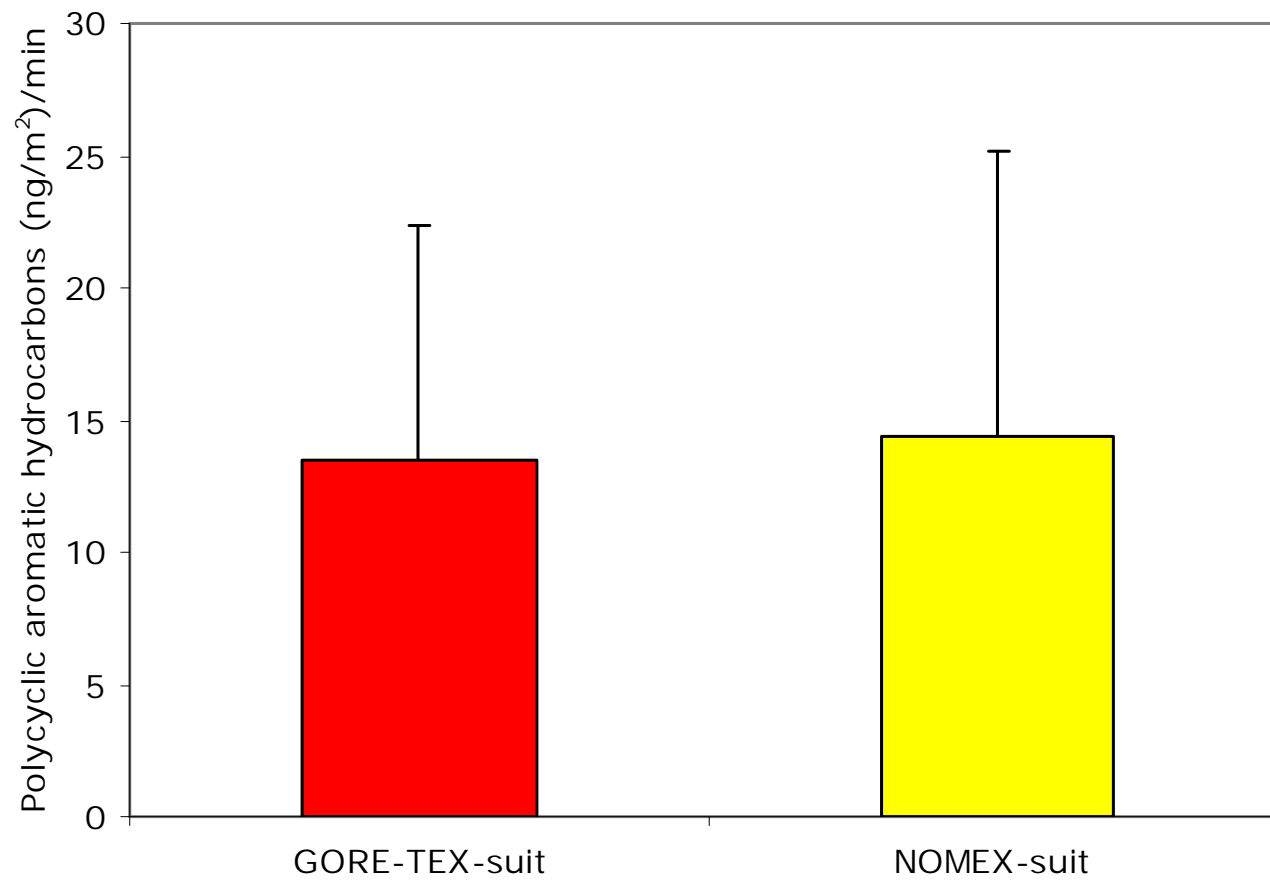


CONTAINER TRAININGS

- To test protection efficiency of two different fire suits during container trainings
 - Brage (NOMEX)
 - Bristol (GORE-TEX)



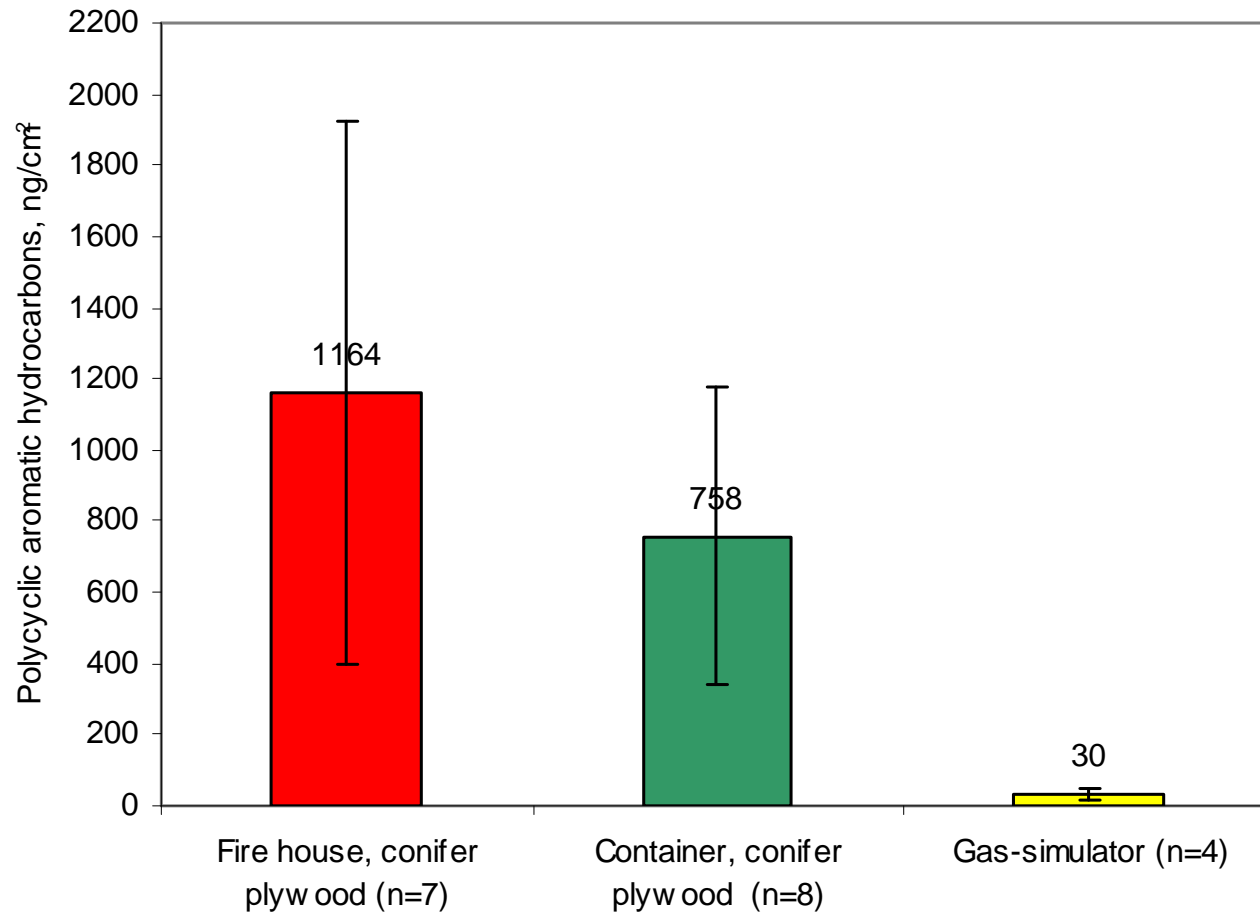
THE PENETRATION SPEED OF POLYCYCLIC AROMATIC HYDROCARBONS THROUGH THE FIRE SUITS



THE AFFECT OF SIMULATOR TYPE ON TRAINERS' EXPOSURE



THE AMOUNT OF POLYCYCLIC AROMATIC HYDROCARBON ON THE SURFACE OF THE TRAINERS' SKIN AFTER TRAININGS IN DIFFERENT TYPE OF SIMULATORS



CONCLUSIONS: burning material

- The highest exposure were measured when conifer plywood board and chipboard was burned
- Pure spruce and pine wood was the safest burning material in Finnish simulators
- The lowest exposures were measured when gas was burned



CONCLUSIONS : Protective equipments

- Under gloves decreased 80 % the amount of polycyclic hydrocarbons in trainers' hands



CONCLUSIONS: Simulator type

- The highest dermal exposures to polycyclic aromatic hydrocarbons were measured in fire house simulator
- The dermal exposure levels were 35% lower in container training than in fire house
- The lowest exposures 4 % of the levels in fire house was measured in gas simulator



RECOMMENDATIONS: burning material

- The safest burning material is glueless wood or gas
- For firing liquid we recommend sinol (80% ethanol)
- The burning of polystyrene foam has to stop without any exceptions



RECOMMENDATIONS: Exposure routes

- *Inhalation exposure* can be decreased by choosing smokeless places for feedback sessions and breaks between smoke diving session. The good manner is to take fire suits off during the breaks
- *Dermal exposure* can be decreased by using under gloves during the smoke diving session and especially during maintenance of smoke diving equipments
- The whole body dermal exposure is possible to decrease choosing right burning materials and getting wash immediately after exposure



RECOMMENDATIONS: SIMULATOR

- According to the our experince trainers' exposures are lower if trainings are carried out in simulator, where is only one floor
- If available is simulator, where is more than one floor, trainings should perform only in one floor at the time.

RECOMMENDATIONS: Exposure follow-up

- Trainers' health condition should be followed more precisely
- Authors recommends urinary 1-pyrenol, 1-naphtol and muconic acid for routine exposure follow-up in smoke diving work
- According to the observations of this study, trainers' exposure to carcinogenic agents can be diminished by re-arranging smoke diving procedures, conditions and regulation.

Thank you for your attention !

