




PROGRAM D

→ **ASSESSING THE IMPACT OF BUSHFIRE SMOKE ON THE FIRE GROUND**

Fabienne Reisen<sup>1</sup>, Min Cheng<sup>1</sup>, Steve Brown, John Mahoney<sup>2</sup>

<sup>1</sup>CSIRO-Marine and Atmospheric Research, Aspendale, VIC  
<sup>2</sup>CSIRO-Manufacturing and Materials Technology, Highett, VIC

Contact: Fabienne.Reisen@csiro.au

PROGRAM D : Program ? - Presentation Title

→ **Objective:**  
**Measure, evaluate and control the personal exposures of bushfire fighters to air toxics**

**Background:**

- Fighting fires is a workplace and the fire-fighter OHS must be protected
- Previous research on exposure levels limited (largely done by USDA Forest Service)
- Bushfire smoke in Australia - composition and the factors of influence are unknowns
- Bushfire fighting practices in Australia - impact on exposure unknown



## → Fire ground - a hazardous environment

$$\text{RISK} = \text{HAZARD} \times \text{EXPOSURE}$$



### Occupational Exposure Standards:

Air inhaled at work should not contain chemical agents at concentrations that produce adverse effects on health, safety or well-being



- ⇒ Assess quality of working environment
- ⇒ Identify areas of unacceptable risks
- ⇒ Develop risk reduction strategies

## → Occupational Exposure Standards

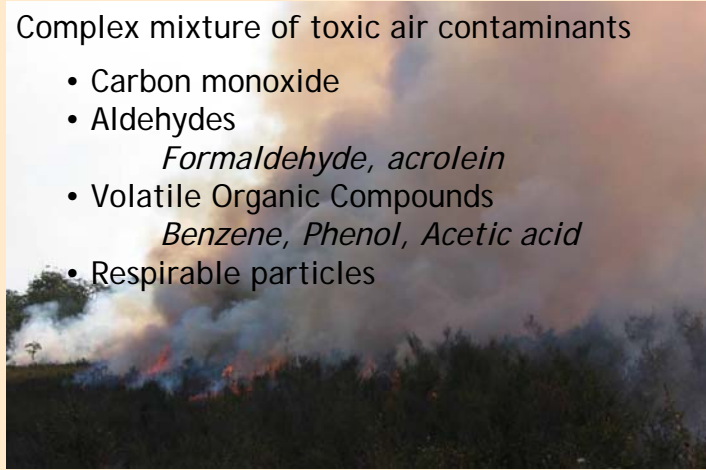
- TWA concentration
  - 8-hr working day, 5-day working week
- STEL concentration
  - not exceed 15 min, not be repeated > 4 times/day, separated by at least 60 min
- Adjustments
  - longer shifts
  - heavy or strenuous work (↑ lung ventilation rate)
- Complex nature of bushfire smoke
  - No standard specific to bushfire smoke particles
  - Interactive health effects



## HAZARD - Bushfire Smoke

Complex mixture of toxic air contaminants

- Carbon monoxide
- Aldehydes  
*Formaldehyde, acrolein*
- Volatile Organic Compounds  
*Benzene, Phenol, Acetic acid*
- Respirable particles



## Bushfire Air Toxics & Health Effects

### Short-term



Eye/nose/throat irritation



### Long-term

Impaired lung function

Aggravation of respiratory and cardiac conditions

Carcinogens

→ EXPOSURE - How to Sample Air Toxics?

- Quantitatively sample bushfire air toxics in the breathing zones of randomly selected fire fighters
  - Key tasks
  - Fuel types
  - Fire types
- Brief interview at the end of each sampling
  - Tasks and reactions to smoke



→ Burns and Fire Attended



Bushfire - Moondarra

Slash burn 33 ha Eucalypt



FRB 5 ha Grassland

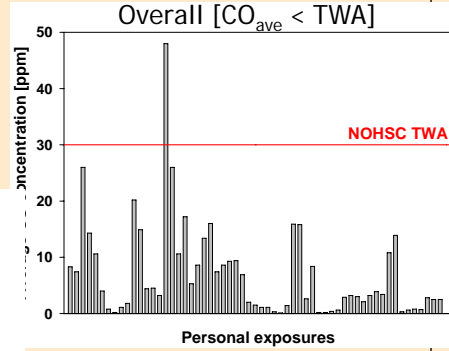
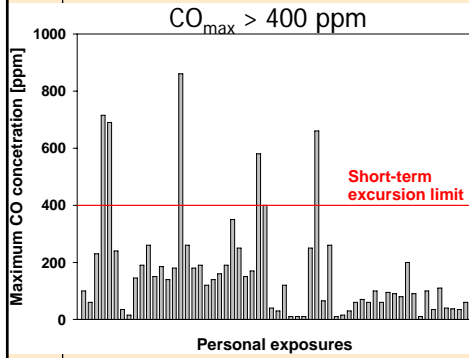


FRB 200 ha Buttongrass Heath



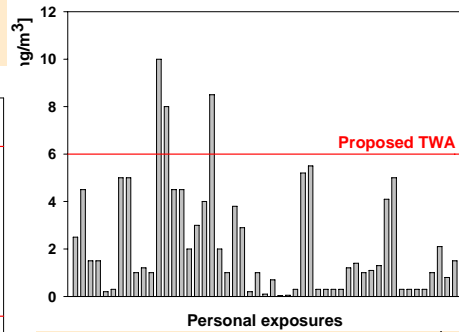
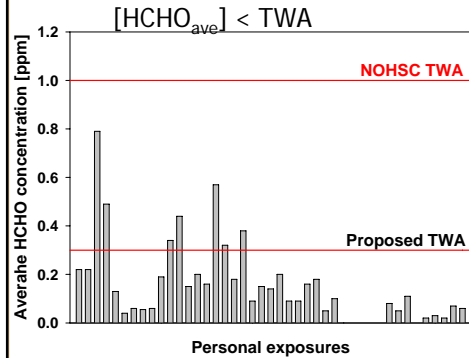
## Personal exposures to CO

COHb levels depend on  $[CO]_{air}$ , exposure duration, ventilation rate, pre-level



- Headaches, dizziness, fatigue, nausea
- Effects on performance of tasks requiring vigilance

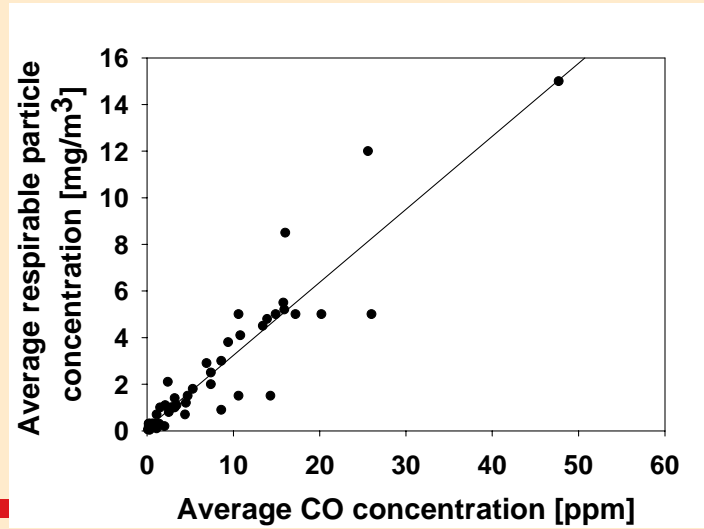
## Personal exposures to respirable particles & formaldehyde



No standard for bushfire smoke particles - composition unknown



## Pollutant Correlation



## Work Activities

1. Lighting



2. Patrolling - including putting out spot-fires (rakehoe or hose)



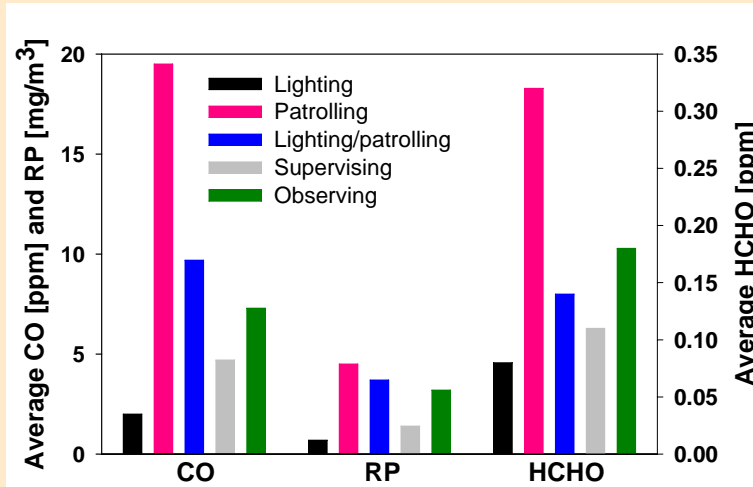
3. Supervising

4. Observing (researchers)

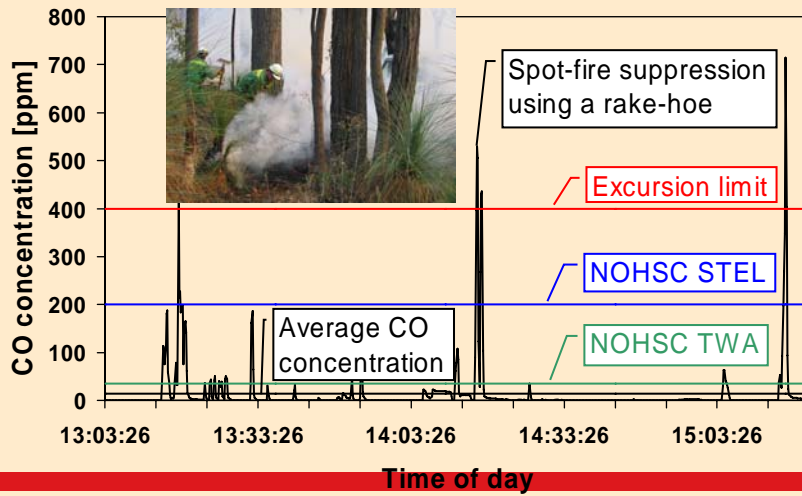




### Personal exposure levels by work activity

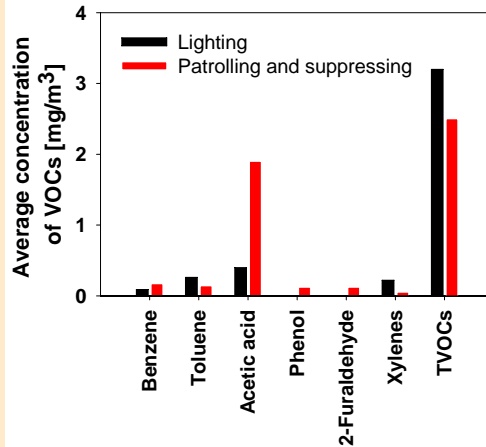


### Data-logger Record of Firefighter's Exposure to CO



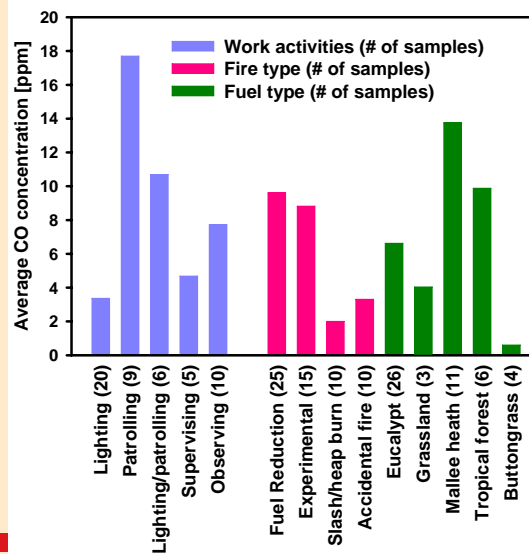
## → Personal Exposure Levels to VOCs

- [VOC] < OES
- Major VOCs at higher levels for the patrolling crews
- Total VOC (TVOC) levels higher for the lighting crew
  - added presence of several alkanes (fuel used in drip torches)



## → Summary

- Variability among exposure levels
- Higher exposures (sometimes exceeding occupational exposure standards) in certain tasks and with certain fuels.







## Control strategies

- CO - elevated short-term exposure levels
  - Sensor, task rotation (mix low/high exposure tasks), hazard awareness training
- Respiratory irritants (respirable particles and aldehydes) - irritation, but also potential to cause long-term health effects
  - Task rotation, face masks or respiratory protection



## THANK YOU

We thank the following agencies for their help and participation in the monitoring process:

DSE, CFA, CFS, DEH, NT Bushfire Council,  
Territory Wildlife Park, Forestry Tasmania,  
CSIRO Sustainable Ecosystems, ENSIS.