Finnish Institute of Occupational Health

I-NAPHTHOL INDICATOR OF DERMAL EXPOSURE TO KEROSENE IN FUEL CELL MAINTENANCE WORK OF MILITARY AIRCRAFT

Laitinen J.,Lehtola M., Mikkola J., Mäkelä M.,
Finnish Institute of Occupational Health
Holopainen J.: Telespro Finland Ltd.
Korhonen M., Malinen A.: Finnish Air Force

WHY THIS STUDY WAS NEEDED ?

- Primary ingredient of the JET-A1-fuel is kerosene, which contains..
  - aromatic hydrocarbons; e.g. benzene.
  - cyclic polyaromatic hydrocarbons; e.g. naphthalene
  - Additive chemicals, which prevent static charge build-up, avoid oxidation, and to decrease corrosion.
  - deicing compounds, e.g. 2-(2-methoxyethoxy)ethanol.

- Adverse health effects of kerosene
  - neurobehavioral and neurocognitive changes
  - posture balance problems
  - effects on reproductive and immune system
  - skin irritations
  - possible increased risk of skin cancer and sensitization

- Dermal exposure to kerosene is more than evident during fuel-cell maintenance and fuelling work phases of military aircrafts

THE AIMS OF THE STUDY

- To examine how different protective overalls can reduce aircraft mechanics' exposure to kerosene ?
- To show how biomonitoring can be very useful tool to test protective efficiency of overalls against kerosene ?

TOPICS OF THE PRESENTATION

- **Topic 1:** Working conditions of fuel cell maintenance work of military aircrafts in Finland
- **Topic 2:** Tested overalls, other protective devices and technical measures.
- **Topic 3.** Measuring methods of exposure and the questionnaire used for testing of usability and comfort of different overalls
- **Topic 4.** Conclusions and recommendations

WORKING CONDITIONS IN FUEL CELL MAINTENANCE WORK

- Original protocol for the maintenance work of fuel cell ignores mechanics' dermal exposure risk to kerosene.
  - Cotton overalls was recommended for this work
- Steps in fuel cell maintenance work:
  - all kerosene has to be removed from damaged fuel cell.
  - fresh air has to flow through the cell until kerosene concentration is clearly lower than flashpoint of kerosene vapours.

WORKING CONDITIONS IN FUEL CELL MAINTENANCE WORK

- Steps in fuel cell maintenance work:
  - fuel injection pumps, lines and inlet have to remove from the cell
  - the holders, whose connect fuel cell to the frame of the aircraft have to cut off.
  - the damaged fuel cell have to press to the little package inside the frame of aircraft.
  - Finally the little package of the fuel cell is pushed out through the little hole of the frame of aircraft.

PERSONAL BREATHING PROTECTOR

PROTECTIVE DEVICES FOR HANDS: NITRILE GLOVES AND TAPED WRISTS

PERSONAL PROTECTIVE SHOES

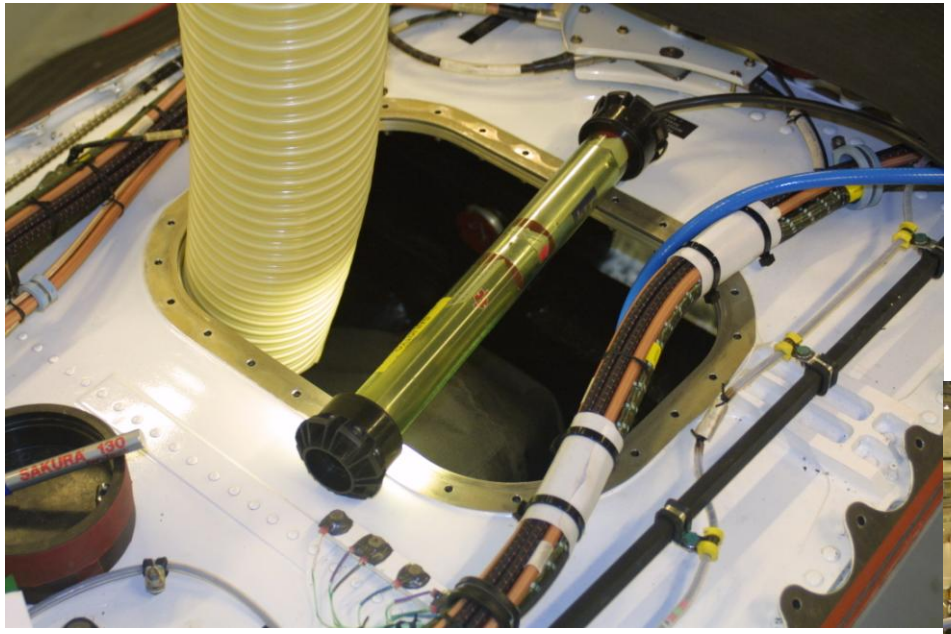
PROTECTIVE OVERALLS

1) Sea-flying overall

2) Tychem® F2

3) Carbon X

TECHNICAL MEASURES

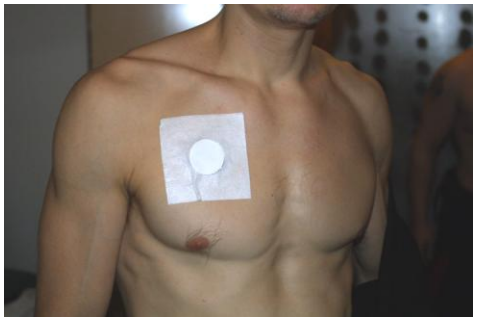


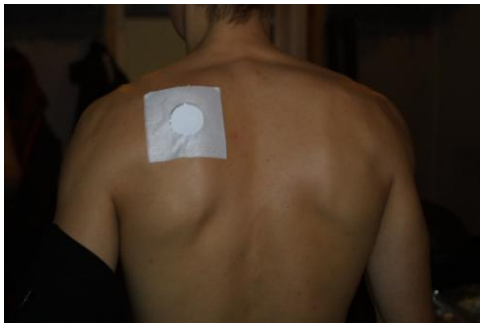
Local ventilator

Vacuum cleaner for liquid kerosene

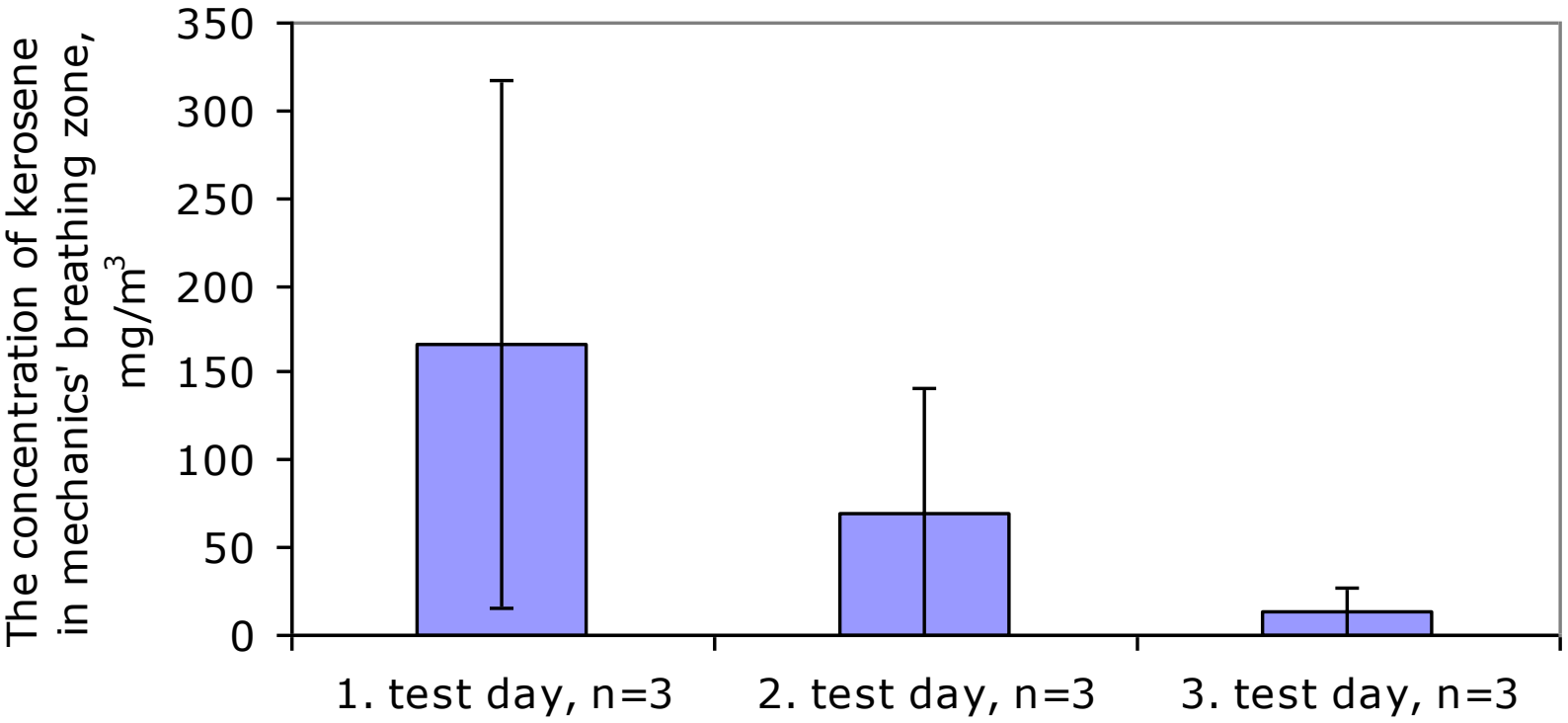
METHODS IN EXPOSURE ASSESSMENTS

- Air concentration of kerosene was measured with diffusion badge from the mechanics breathing zone
- Dermal exposure to naphthalene, surrogate of kerosene exposure, was measured from the surface of body (chest and back) and from the hands
- Total exposure to kerosene were measured following mechanics' urinary 1-naphthol excretion before exposure, immediately after exposure, 6 hours after end of the exposure and next morning.
- The usability and comfort of the overalls was recorded by questionnaires after every tests

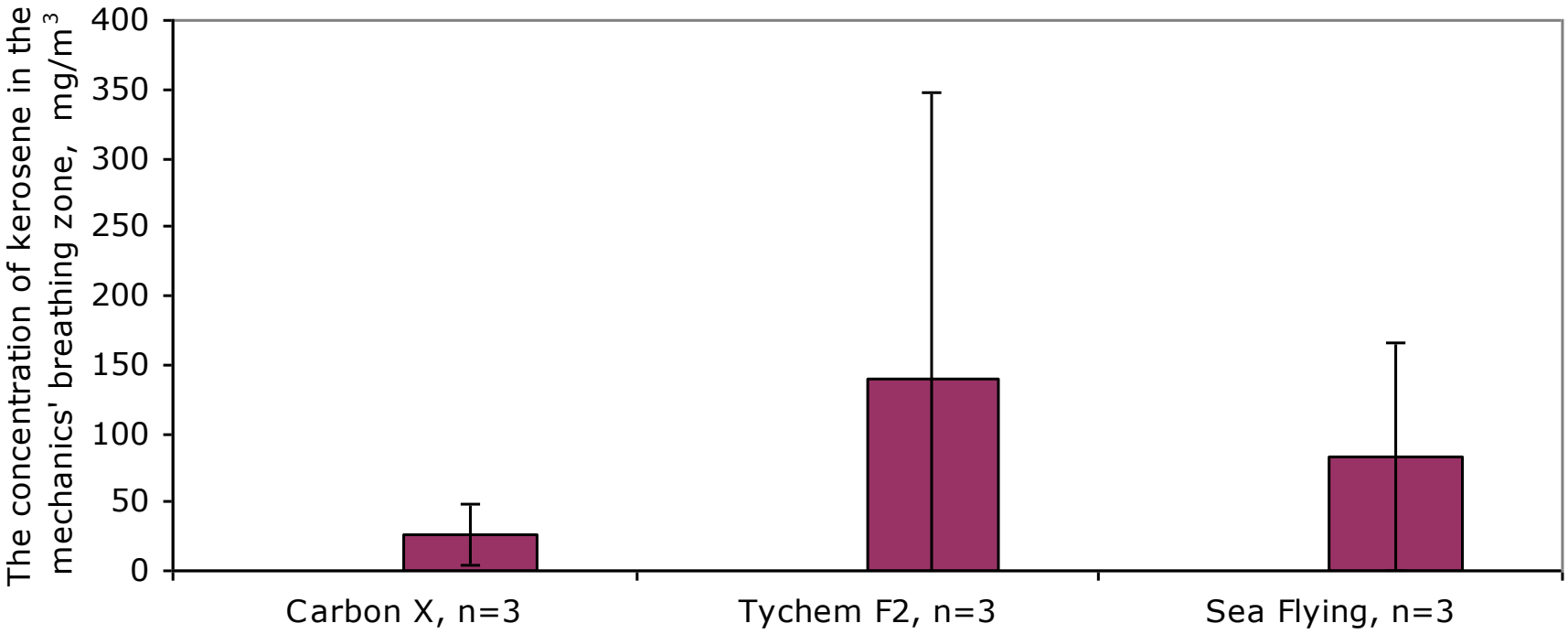




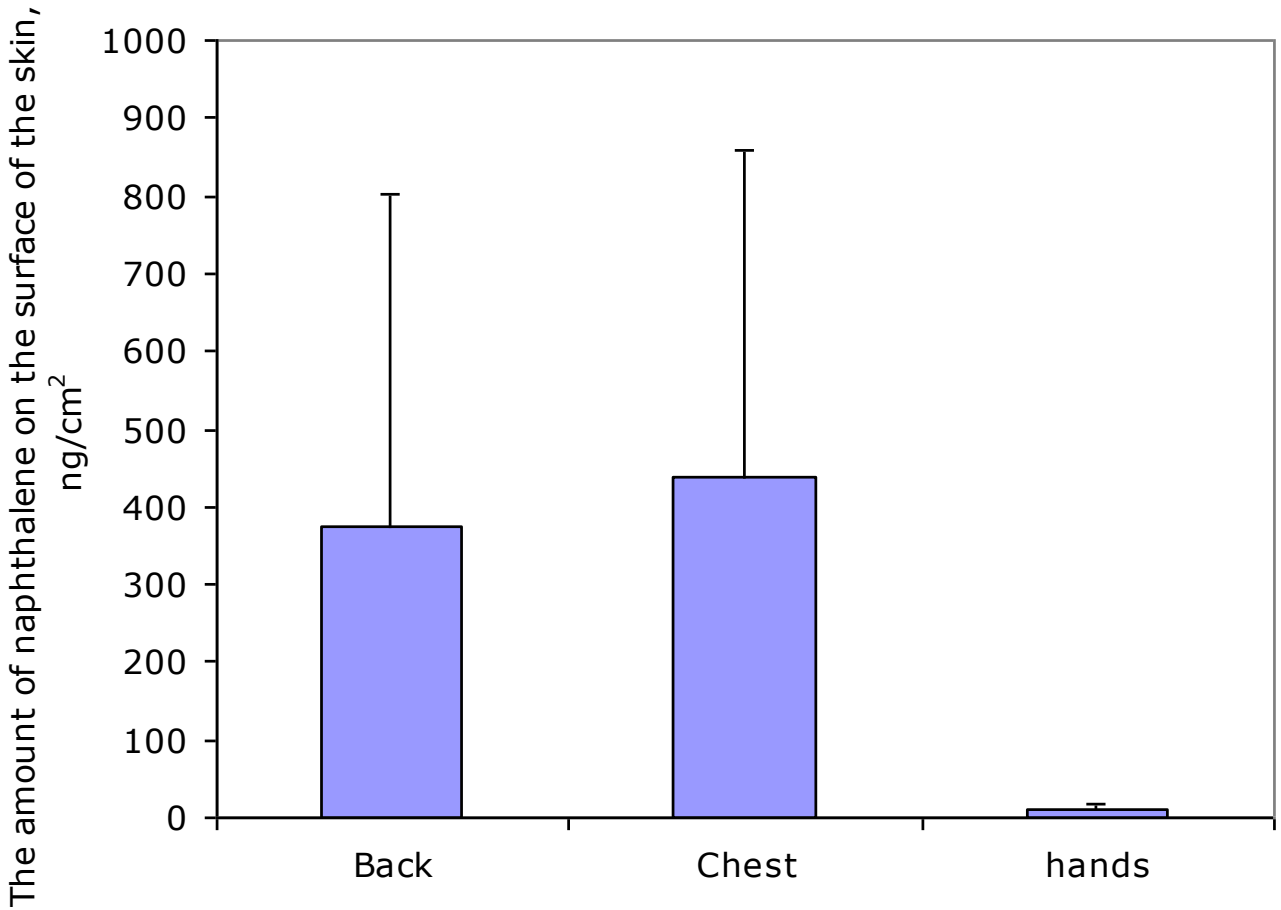
THE CONCENTRATION OF KEROSENE IN MECHANICS' BREATHING ZONE ON DIFFERENT TEST DAYS



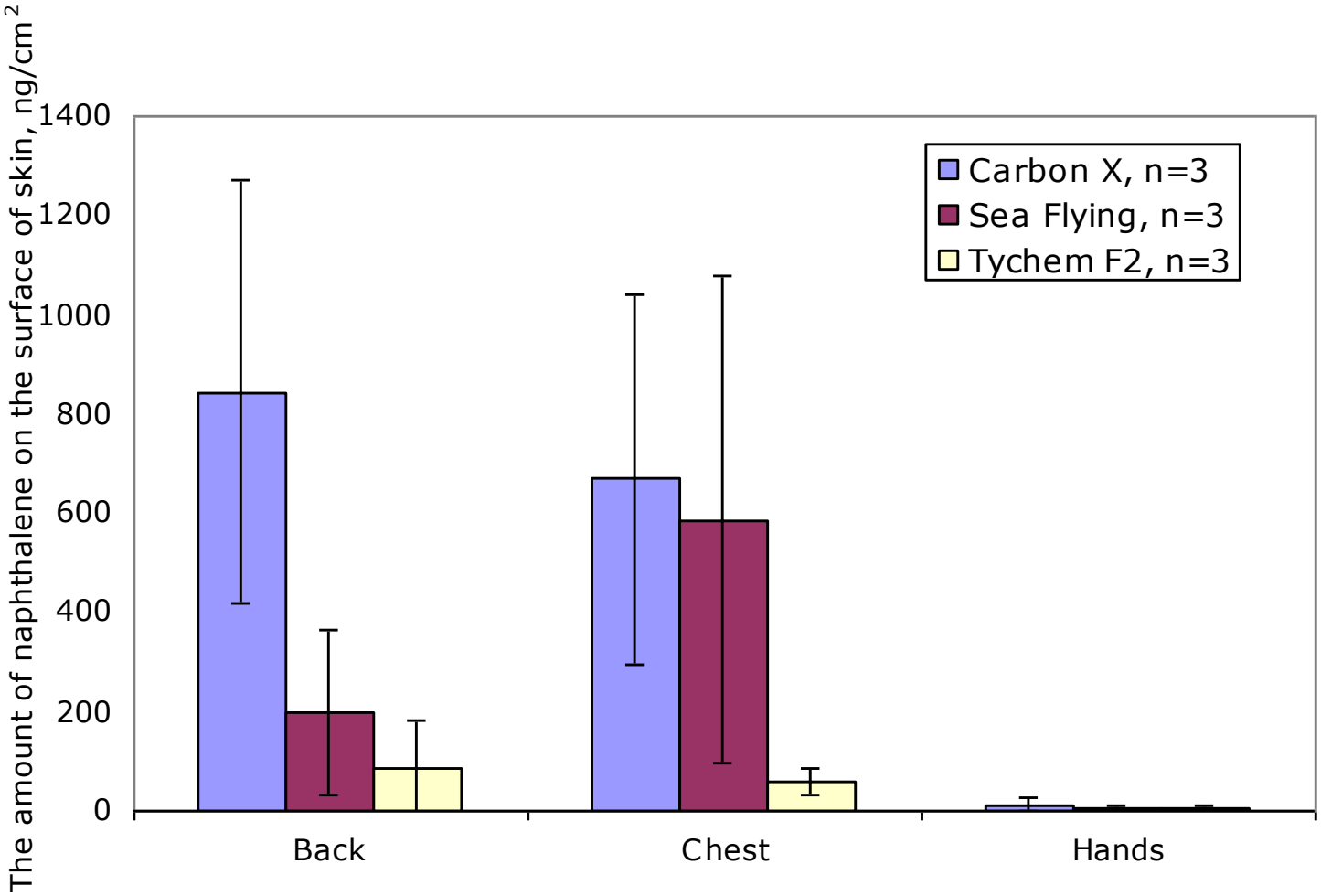
THE CONCENTRATION OF KEROSENE IN MECHANICS' BREATHING ZONE, WHEN WEARING DIFFERENT OVERALLS



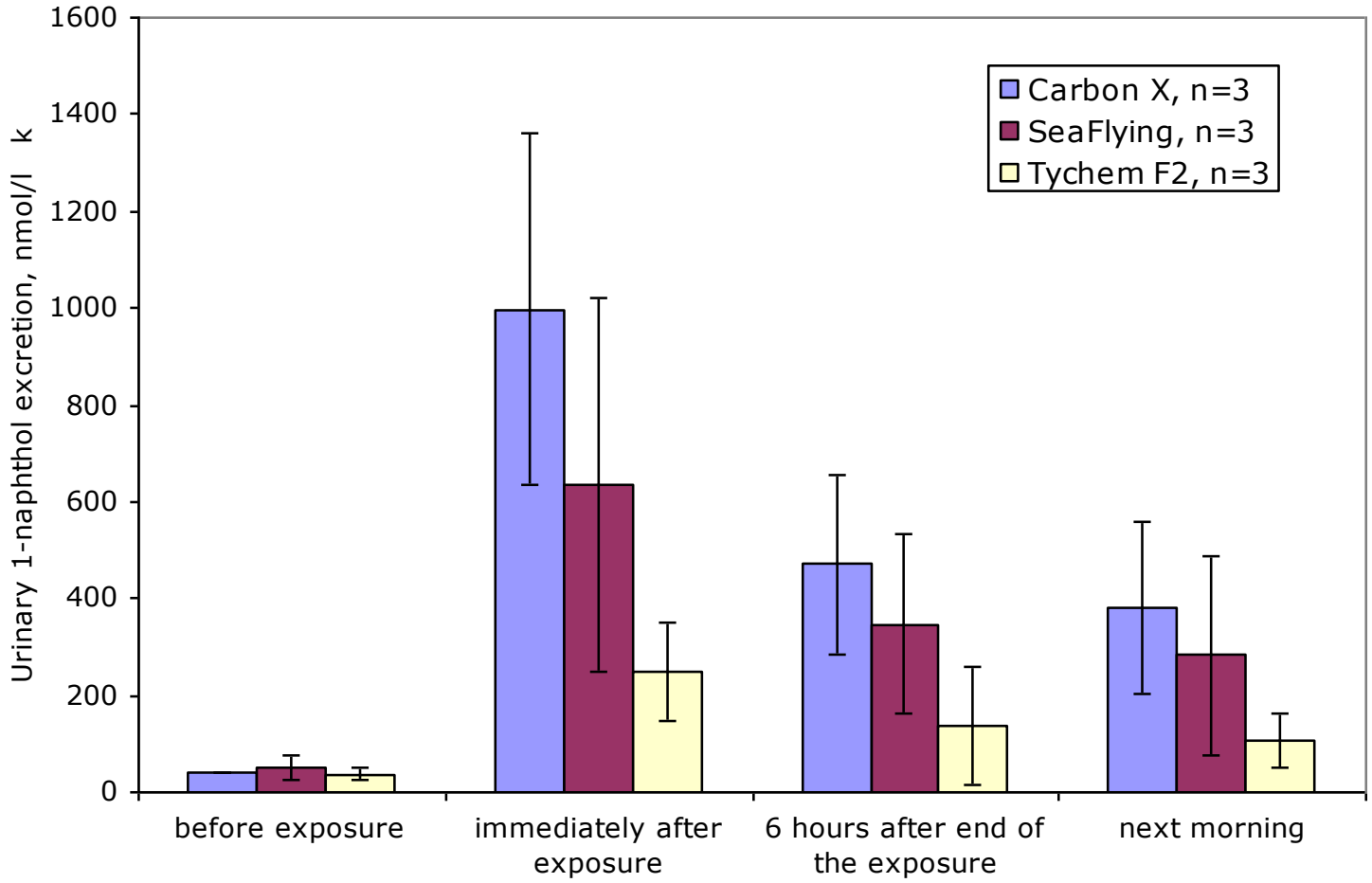
THE AMOUNT OF CYCLIC POLY AROMATIC HYDROCARBONS IN DIFFERENT PART OF THE BODY



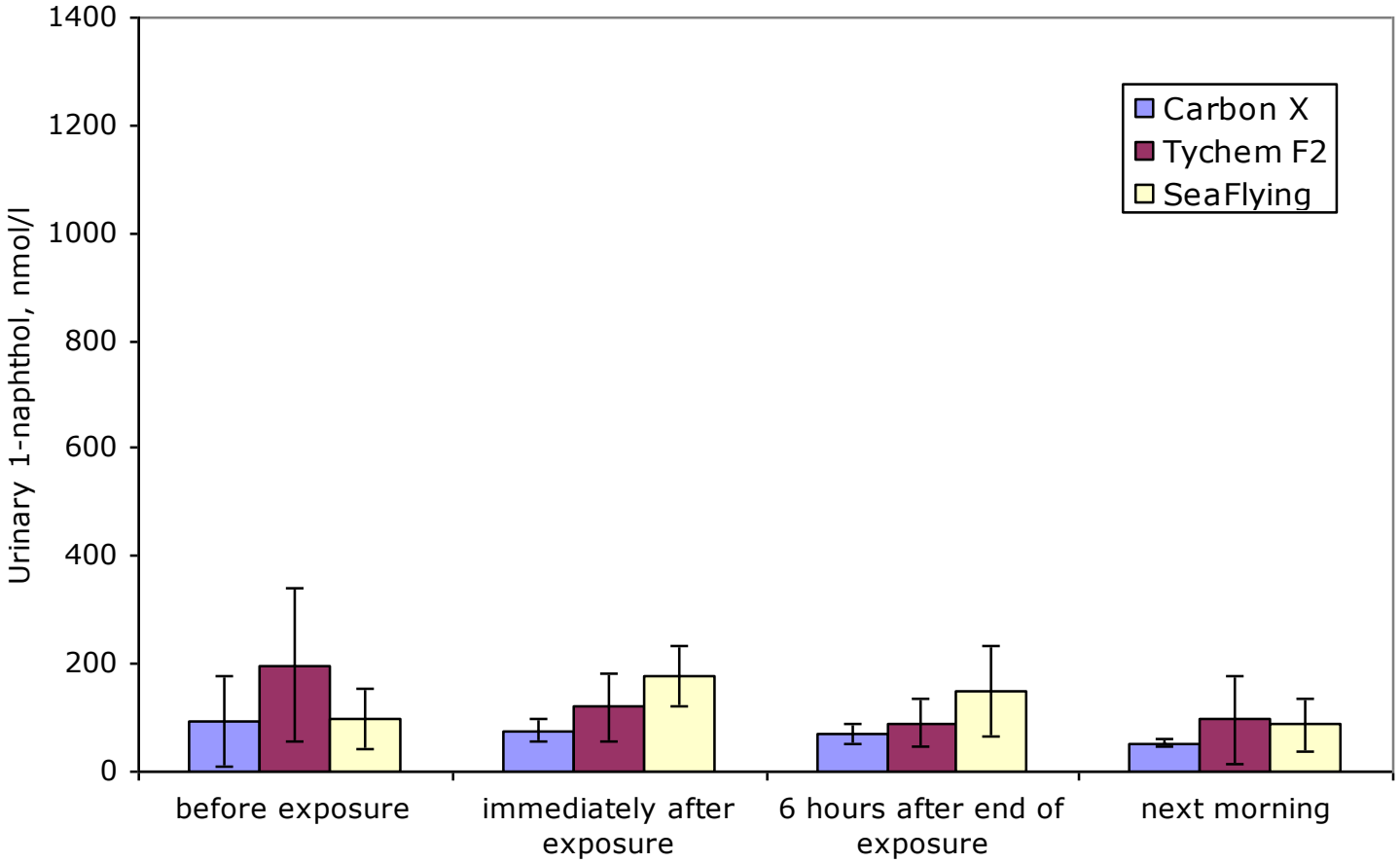
THE AMOUNT OF CYCLIC POLY AROMATIC HYDROCARBON ON THE SURFACE OF THE MECHANICS' SKIN AFTER USE OF DIFFERENT OVERALLS



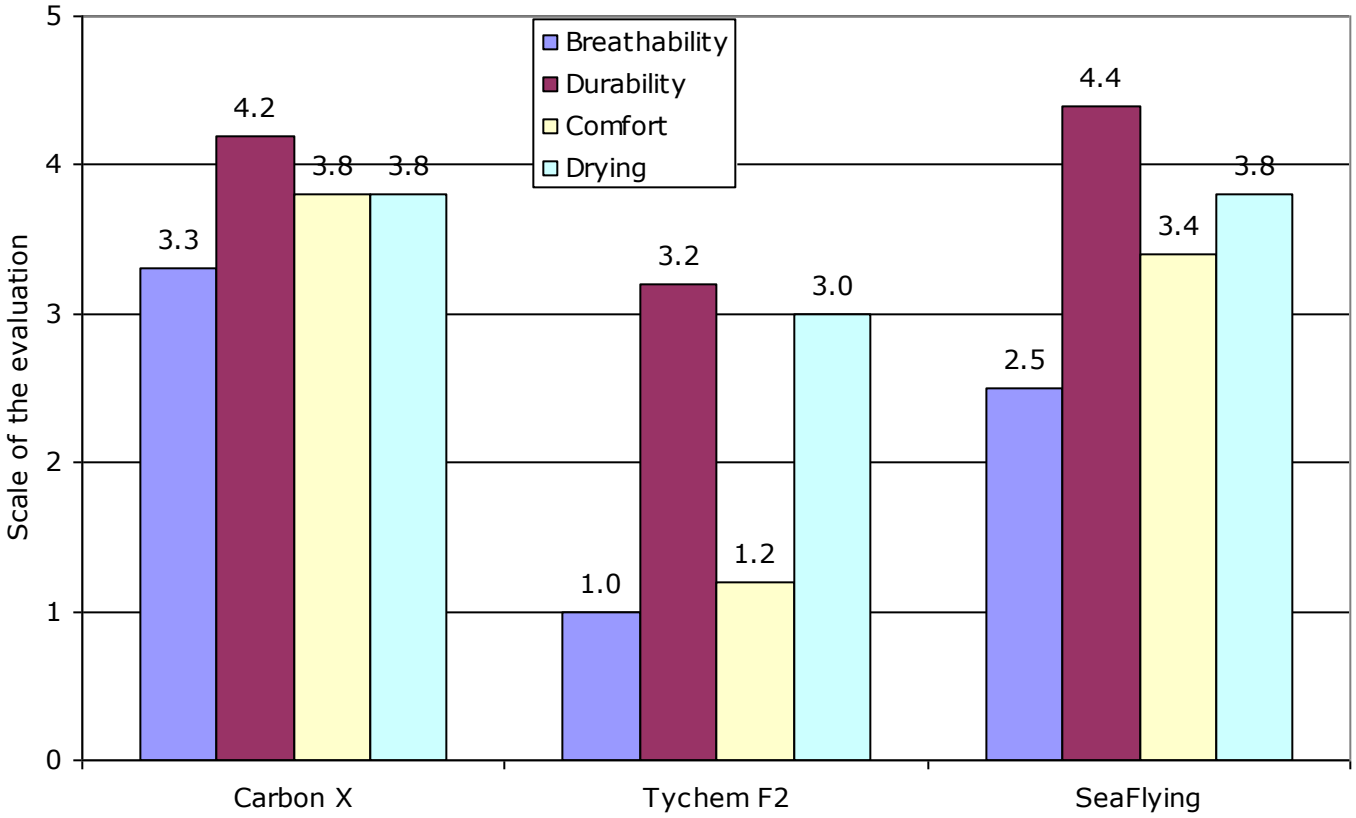
MECHANICS' URINARY 1-NAPHTHOL EXCRETION AT FOUR TIME POINTS AFTER USING DIFFERENT OVERALLS, WHEN WORKING ON FUEL CELL



MECHANICS' URINARY 1-NAPHTHOL EXCRETION AT FOUR TIME POINTS AFTER USING DIFFERENT OVERALLS, WHEN WORKING ON THE WING



USABILITY OF THE OVERALLS



CONCLUSIONS

- The best overall, as regards exposure, was Tychem F2 which showed clearly the best performance in all work phases.
- The second was the SeaFlying overall and the third our experimental overall.
  - Despite of the weakest performance of our experimental overall its performance was much better that earlier used cotton overall.
- As regards the usability and comfort, our experimental overall was the best.

RECOMMENDATIONS

- Tychem F2 overall was recommended to mechanics who have to work inside of the fuel cell especially during wet work phase.
- Because of the heat stress of tested overalls; the continuous working periods, exceeding 30 minutes inside the fuel cell, should be avoided.
- Workers heat stress and liquid balance must follow fuel cell maintenance work.
- Urinary 1-naphthol tests is recommended as a tool to control mechanics' exposure to kerosene and functioning of protective equipments.
- These biomonitoring test should be carried out at least once in year, or more if;
  - something changes in the work such as protection devices or work methods
  - workers have symptoms.