
Influence of Good Working Practice on Exposure – Example Spray Application

Workshop: Occupational Safety and Health during the use of biocides – 3. – 4. April 2006 (BAuA, Dortmund, Germany)

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Research project: „Workplace exposure from the use of biocidal products – Part 1: Inhalation and dermal exposure data for the spray application of liquid biocidal products“

EU Biocides Directive 98/8/EC – requires exposure assessments

Focus: Biocidal products applied via spraying:



Compilation of biocidal products applied in Germany



Simulation measurements in model rooms



Field measurements at selected workplaces in different industries



Development of a suitable model - **Spray Expo**



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Approach - Occupational situation:

- ➔ Identification of relevant **workplace situations**/relevant **spraying devices**
- ➔ **Aerosol spraying** in model room with tracer solutions - **Defined conditions**
- ➔ Determination of **inhalation** and **potential dermal** exposure –
- ➔ **Field measurements** – comparable results?
- ➔ Identification of parameters **influencing** and **determining** the **extent of exposure**



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Relevant working places, where biocides are applied by spraying or fogging:

- Disinfection/Crop spraying in hospitals, canteen kitchens, stables
applies for **product type 2, 3, 4 – Disinfectants and general biocidal products**
- Protection of food- or feedstuff in transport or storage
applies for **product types 14, 15, 16, 18, 20 – Preservatives**
- Wood and masonry preservatives
applies to **product types 7, 8, 10, 21 – Pest control**
- Antifouling product application
applies to **product type 21 – Other biocidal products**

Determination of **inhalative** and **potential dermal** exposure of **professional** applicants



Simulation measurements in model rooms

Measurement of inhalation exposure - Personal Aerosol Monitor – Respicon

Respirable, thoracic, inhalable fraction

3 Spray applicators:

Low pressure sprayer (**2 bar**)

250 ml/min

980 ml/min

droplets: **100 – 300 μm**)

High pressure sprayer (**160 bar**)

133 ml/min

200 ml/min

droplets: **30 – 50 μm**)

Fogging apparatus

very small droplets



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Simulation measurements in model rooms

Model rooms – 5.7 m x 4.2 m x 2.5 m (appr. 60 m³), 1 window, 1 radiator; walls and ceiling coated with woodchip paper, painted with wall paint; synthetic carpet

Spraying situations:

- ◆ Floor and lower part of the wall
- ◆ Ceiling and upper part of the wall
- ◆ Wall (horizontal spraying) – airless spraying
- ◆ Total room (only fogging apparatus)

Application time:

6 – 26 minutes

Sprayed solutions:

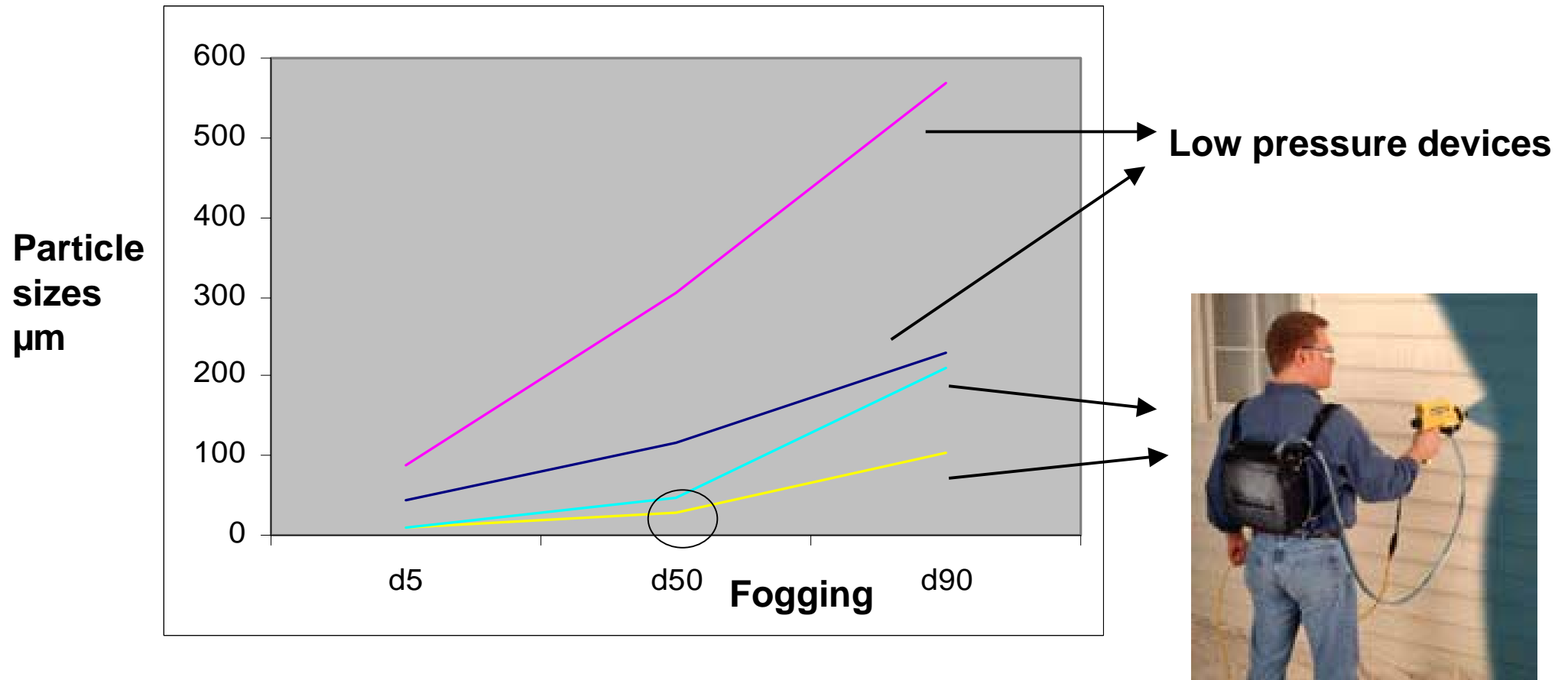
- ◆ 1% fluorescein-Sodium (aqueous)
- ◆ 7-diethylamino-4-methylcoumarin (organic)

as fluorescence tracers and surrogates for active ingredients

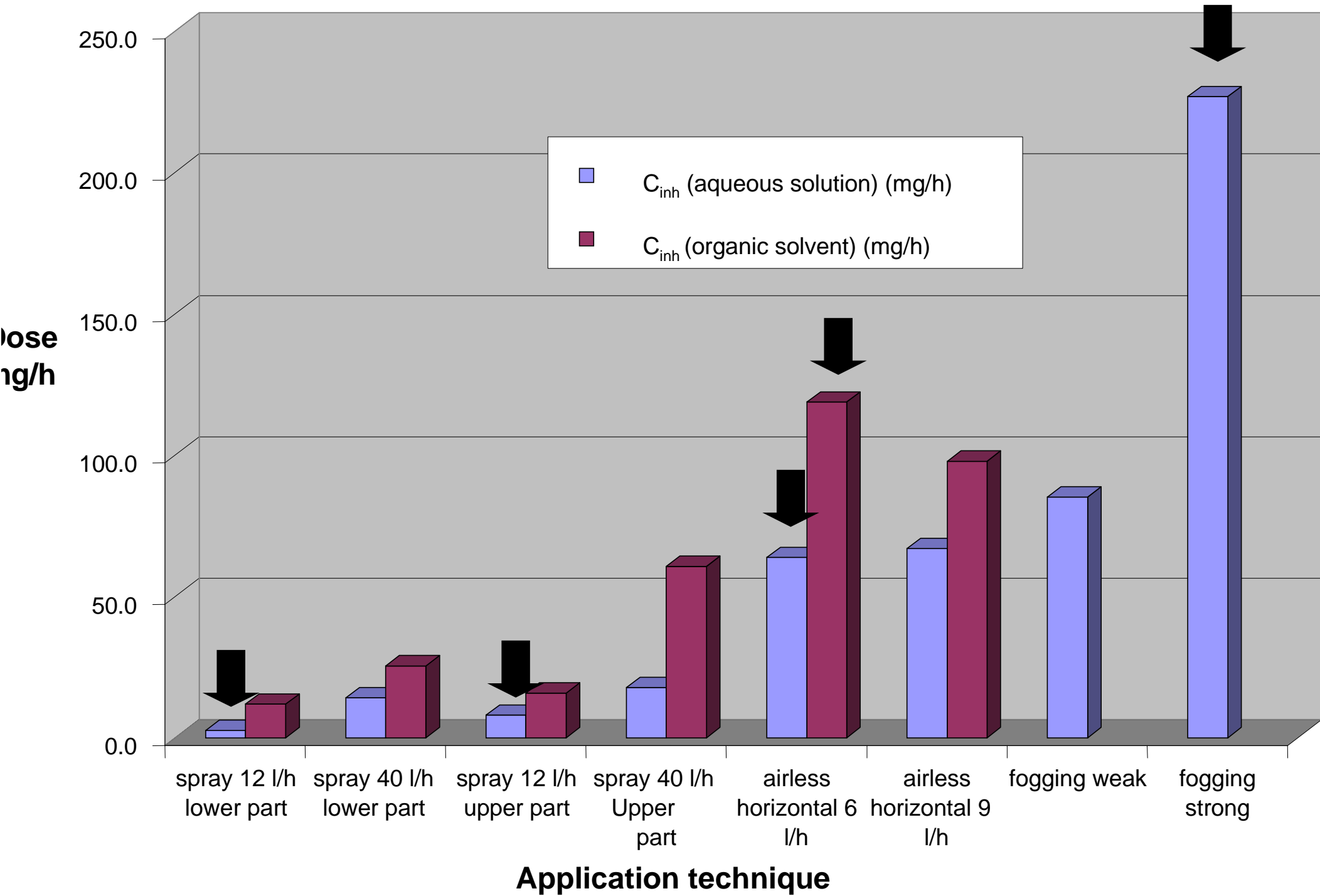


Simulation measurements in model rooms

Particle distribution of the used spraying devices



Inhaled doses – model experiments – personal sampling

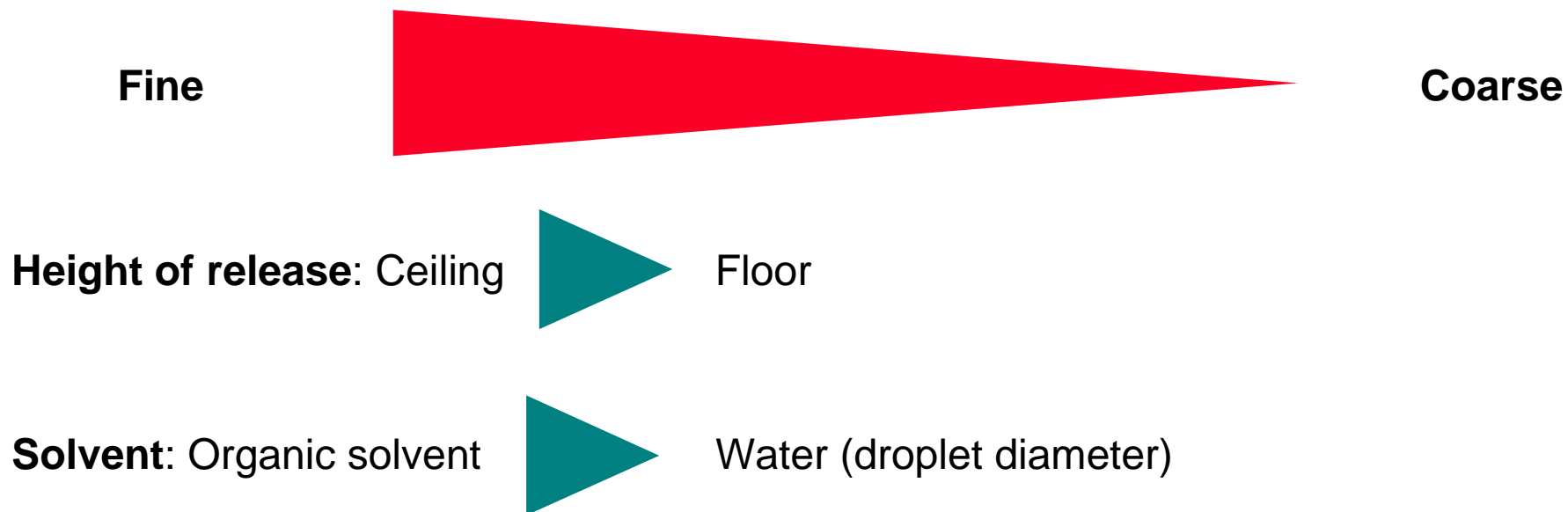


Simulation measurements in model rooms

Results of model measurements – Inhalation exposure

Inhaled doses: Fogging > airless spraying > spraying with low pressure

Droplet spectrum (size distribution):



Simulation measurements in model rooms

Determination of Potential dermal exposure

Pads on different body parts:

Head, Chest outer and inner, Back outer and inner, Upper arms, Forearms, Thighs, Shins; Hands (not in all cases)

Size of pads

100 cm²

Calculation of potential dermal exposure using factors:

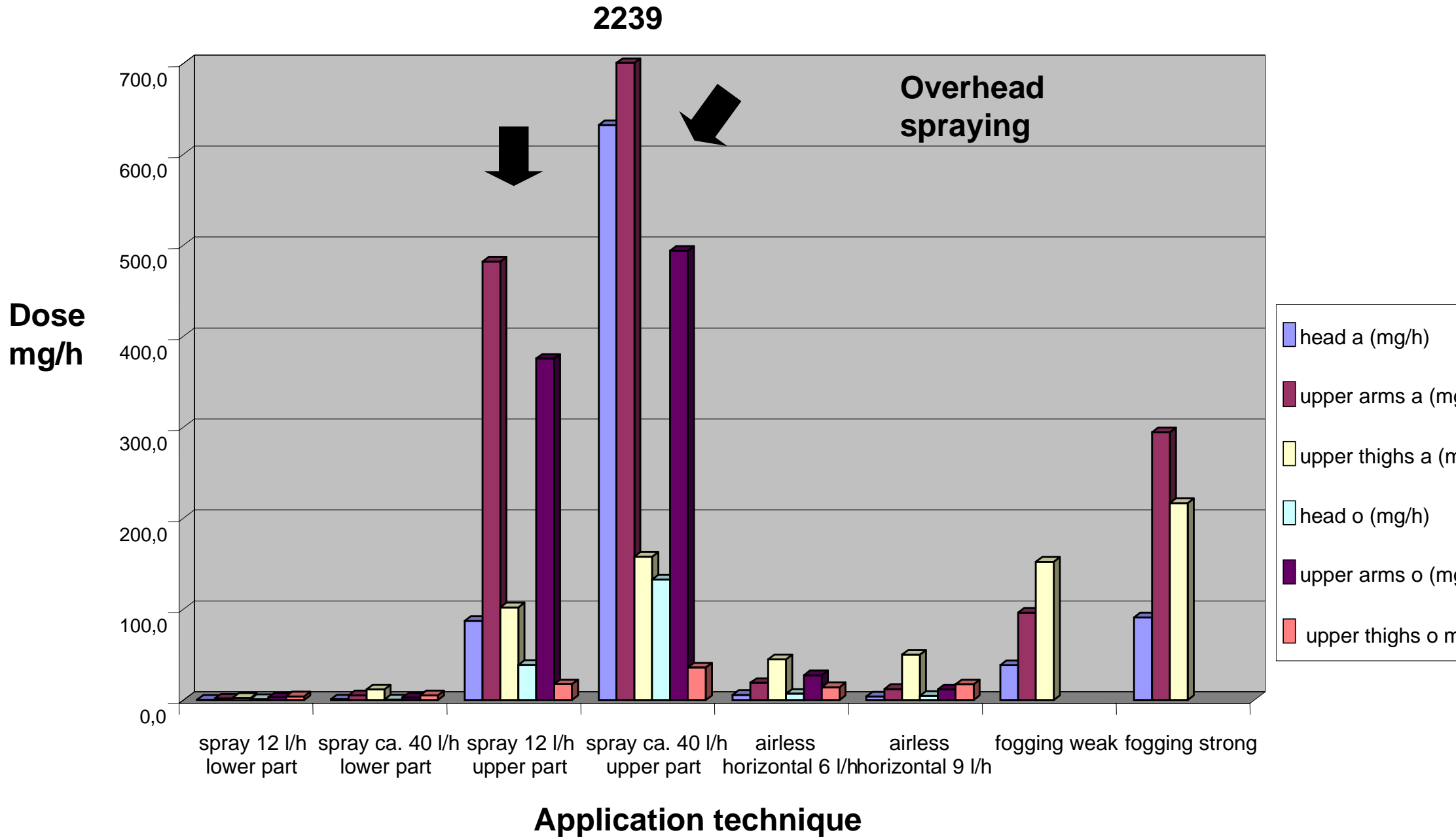
80th percentiles of body surfaces^{1,2}

¹ OECD Guidance Document for the Conduct of Studies of Occupational Exposure to Pesticides During Agricultural Application, 1997

² EPA-Factor's Handbook, 1995, 1997



Potential dermal exposure – model experiments - Pads



Simulation measurements in model rooms

Results of model measurements – Potential dermal exposure

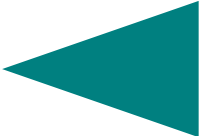
Potential dermal doses:

Spray low pressure (ceiling) > Fogging > airless spray > spray low pressure (floor)



Large differences: total dermal doses varied from **10 mg/h to 5000 mg/h**

Direction of spraying: Ceiling  Floor

Solvent: Organic solvent  Water (higher vapour pressure of organics)



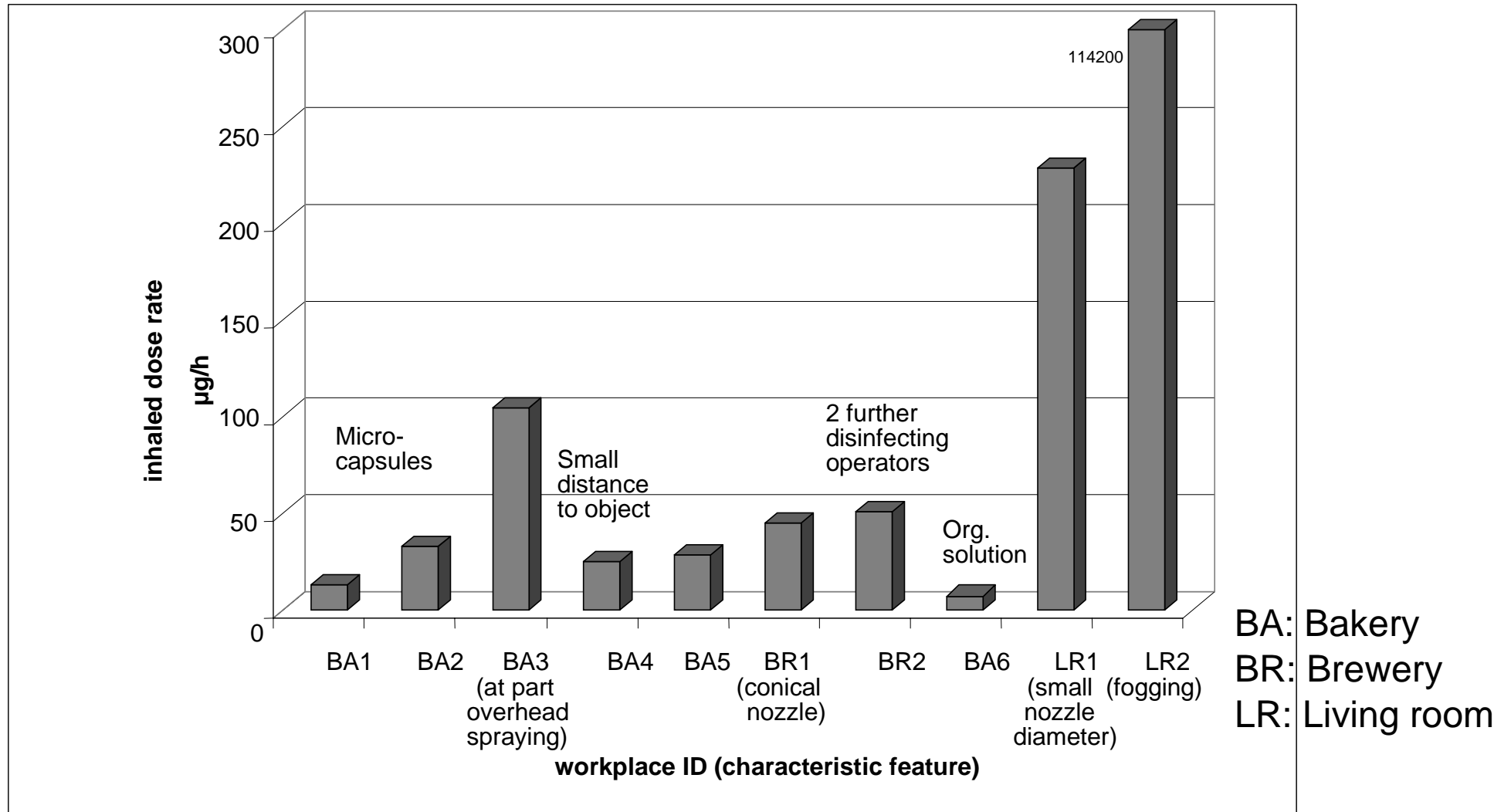
Field measurements

Workplace measurements

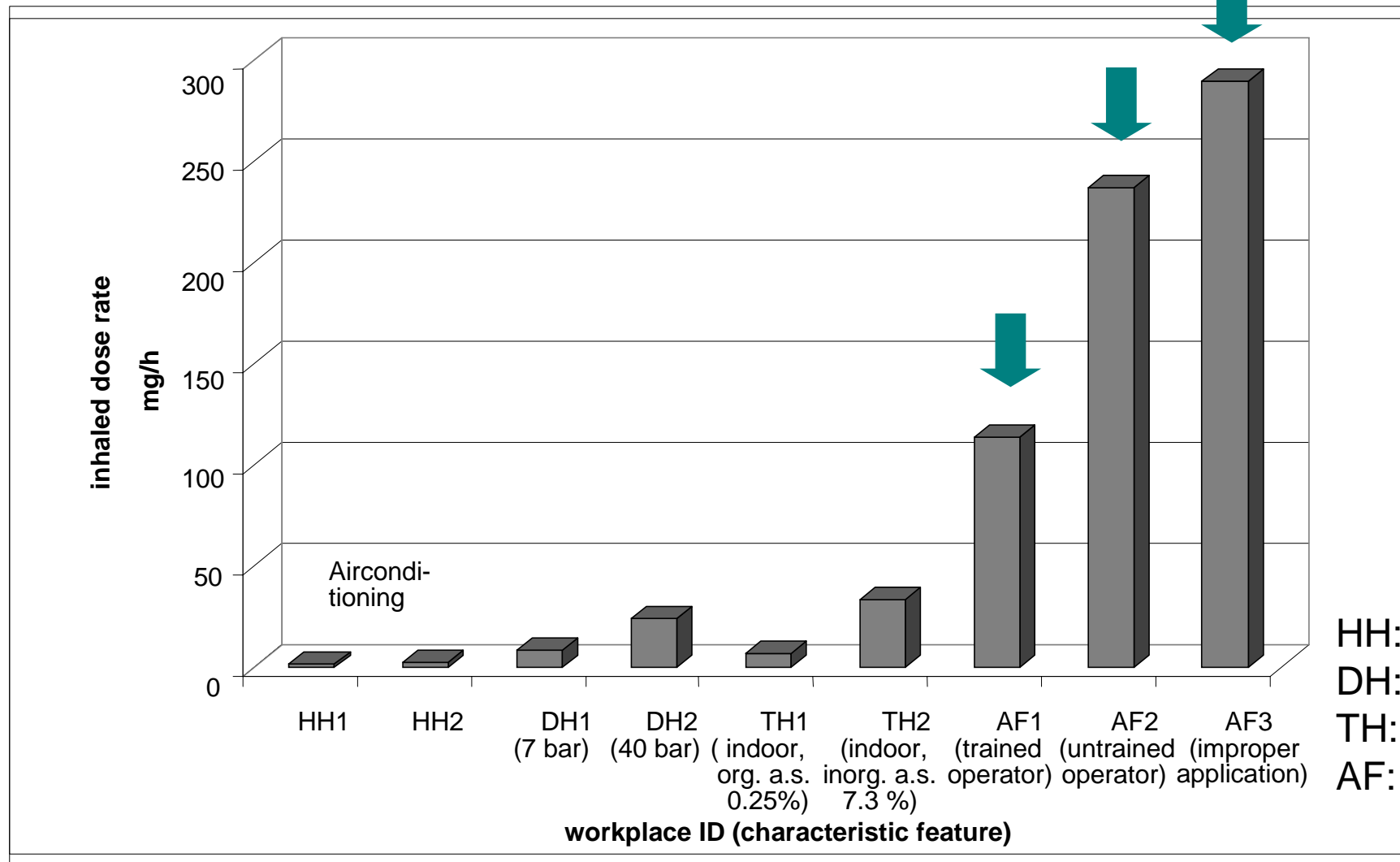
Area of biocide application	Workplace	Remarks
Food and feed area disinfection	Bakery (BA 1-6)	2 microcapsulated products
	Brewery (BR 1-2)	Futher disinfectors in room
Private area and public hygiene	Living room (LR 1-2)	Small nozzle diameter, fogging
Veterinary hygiene	Henhouse (HH 1-3)	Water based products, Aircondition
	Duckhouse (DH 1-2)	Water based products
Wood protection	Timber house (TH 1-4)	(water based, 2 indoor, 2 outdoor)
Antifouling	Piece of metal (AF 1-3)	Trained – untrained operator



Inhalation exposure at selected workplaces



Inhalation exposure at selected workplaces





HH: Hen house
DH: Duck house
TH: Timber house
AF: Antifouling



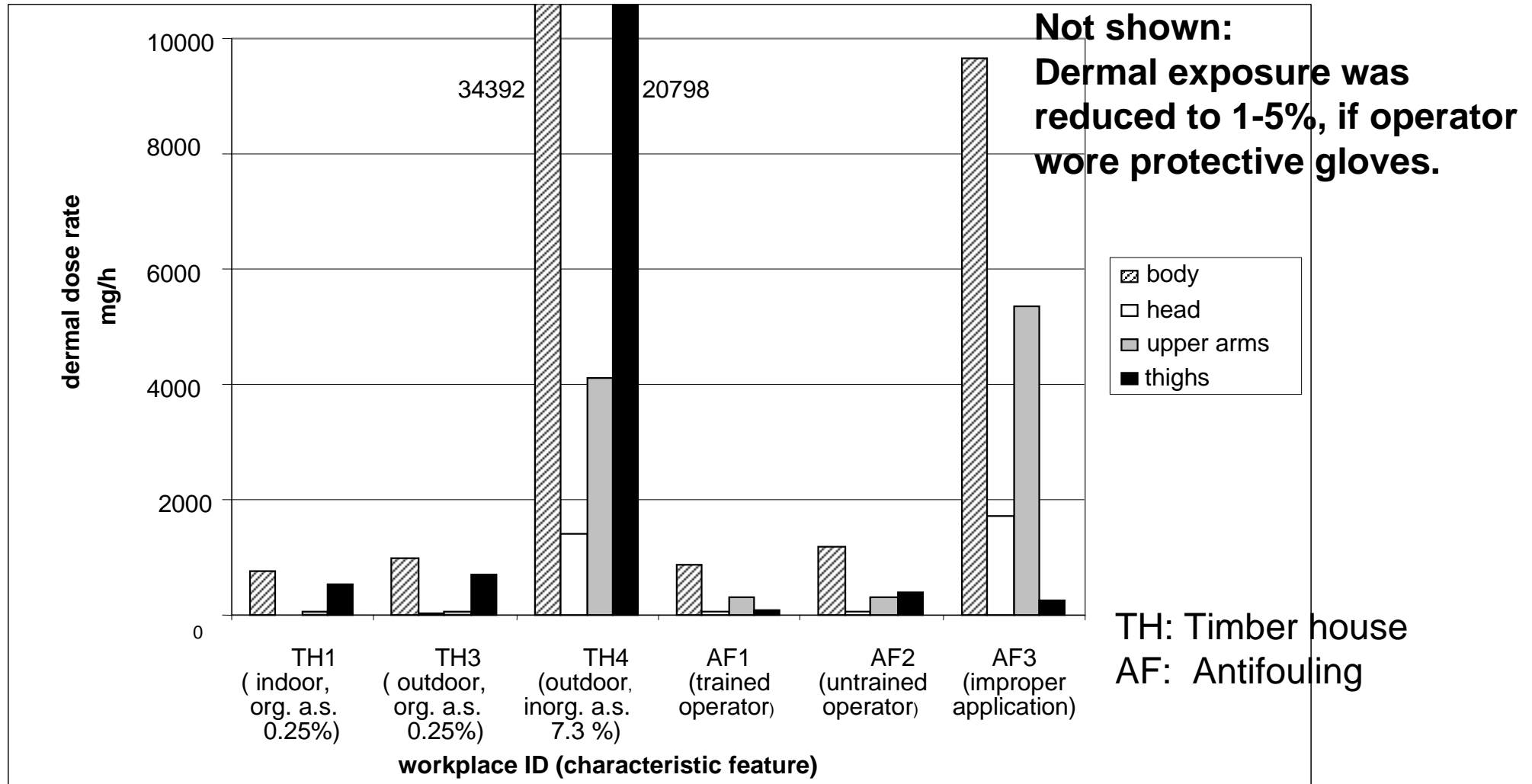
Field measurements – factors influencing exposure

Results of Workplace measurements – Inhalation exposure – Summary

Inhaled doses increase 	Inhaled doses decrease 
Overhead spraying Bakery	Air-conditioning Hen houses
Pressure during application Duck houses	Training/proper application Antifouling
Small nozzle diameter (fogging) Living room	Outdoor application Timber houses
Concentrated solutions Timber houses	



Potential dermal exposure



Influence of Good Working Practice on Exposure

Inhalation and Potential Dermal Exposure during Antifouling treatment:

Trained operator (Professional) >>> Untrained operator >>> improper application (elevated operating pressure, fawning), hand protection

National Technical Rules for hazardous chemicals describe proper working conditions: →

→ Airspray technique forbidden

→ Suitable spraying devices and spraying directions given
Frequent information of operator

Inhalation Exposure during disinfecting treatment in air conditioned rooms:

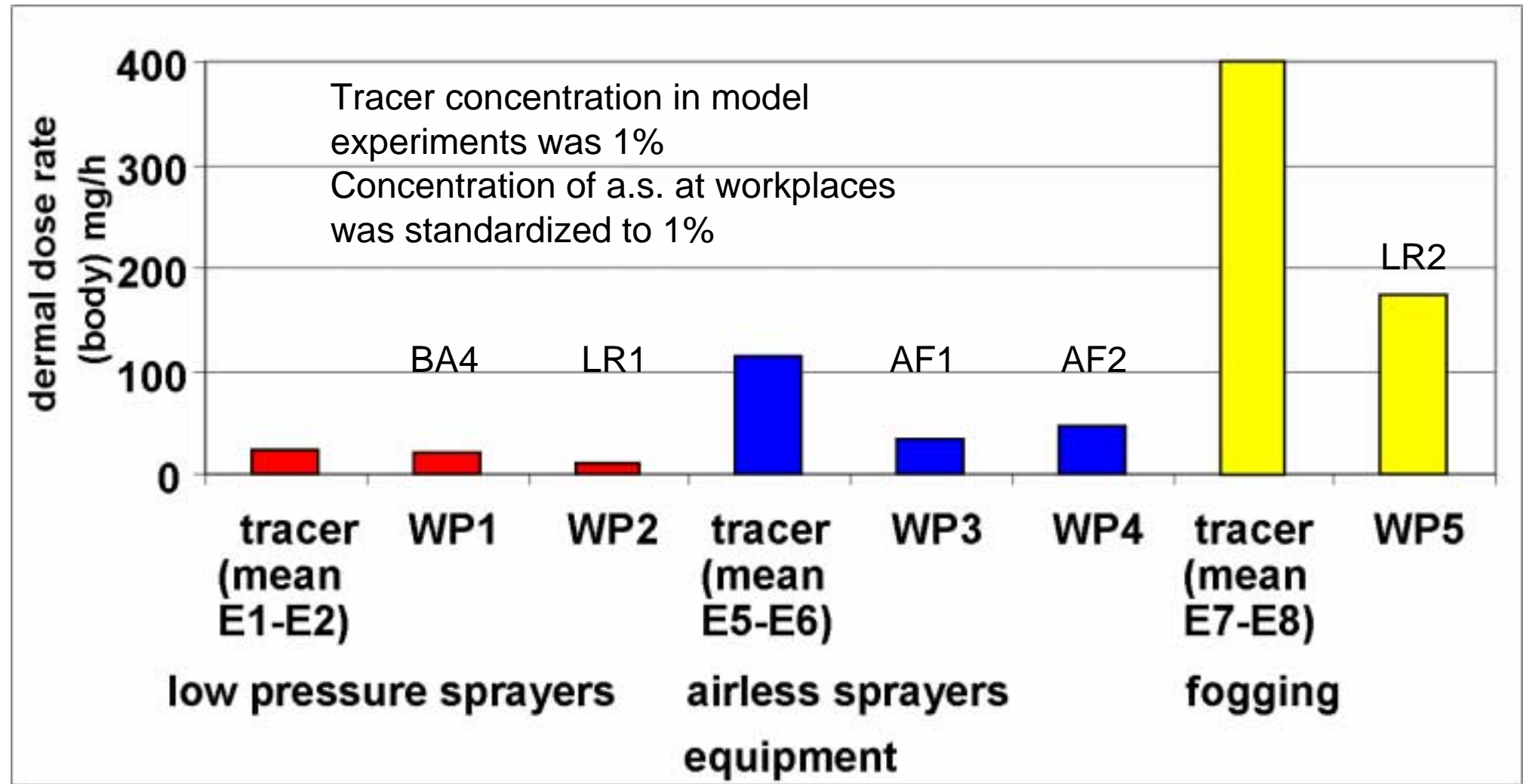
Henhouse (air conditioning) >>> Duckhouse (no air-conditioning)

Inhalation Exposure in bakeries

Use of microcapsulated products reduce inhalation exposure



Dermal Exposure at model experiments (E) and at workplaces (WP)



Summary

Relevant parameters influencing the extent of exposure are:

Inhalation:

- Type of spraying (fogging >> airless >> low pressure)
- Droplet size (fine >> coarse)
- Height of release (ceiling >> floor)
- Solvent (organic solvent >> water)
- Working place environment (Airconditioning >> no air-conditioning)
- Good working practice (trained operator >> untrained operator >> improper application)
- Use of microcapsulated products

Dermal:

- Spraying direction (Overhead >> Floor)
- Solvent (Water >> organic solvent)
- Good working practice (trained operator >> untrained operator >> improper application, hand protection)



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Project was performed at Fraunhofer ITEM Hannover on behalf of BAuA (1998 – 2004)

-Prof. Dr. W. Koch (ITEM)

-Dr. Berger-Preiß (ITEM)

-Dr. Mangelsdorf (ITEM)

-Dr. Boehncke (ITEM)

-Dr. Könnecker (ITEM)

-Dr. Holthenrich (BAuA)

-Dr. Auffarth (BAuA)



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