

Monitoring worker exposure to benzene in a bulk liquid storage terminal

IOHA London 2015



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Caesar Consult Nijmegen



English

About us

Caesar Consult is a consultancy in the field of Industrial Hygiene and Occupational toxicology

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Agenda

REACH Module 3a
11 March 2015
REACH Module 3b
12 March 2015

Contact

Call or email us directly

Our mission

Safe and healthy working conditions for everyone who works with hazardous substances



Background

Case

Bulk liquid storage terminal

Storage and transloading of fuels & bulk chemicals
(*petroleum products*)

Variable / flexible tasks

Short-term, frequent operations

Outdoor

Strict safety regime (fire / explosion)

Frequent PPE use

Is exposure to VOC controlled?



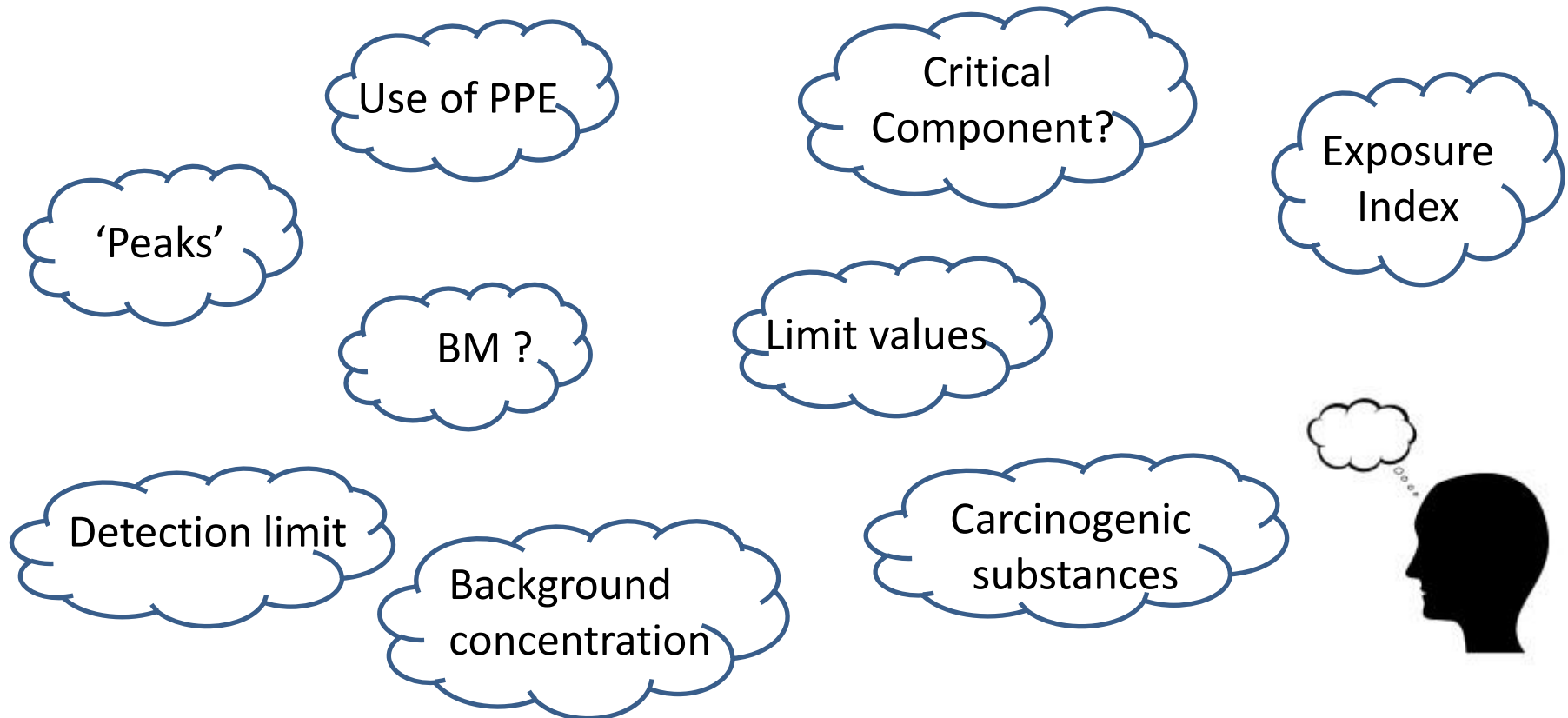
Background

What to do...

Mission: Measurements!

Number of products: >200

Setting: concern among employees



Methods

Type of measurements

Personal air sampling (8-h)

- 3M-badge (passive)
 - benzene + VOC screening
 - validated quantitative measurements
- PID-meter
 - level total VOC
 - ‘peak moments’



Urine measurements (end-shift)

- t,t-muconic acid in urine – *specific biomarker for benzene*



Registration of tasks

- activities
- products / substances
- Use of PPE

Controls

- office employees - *same measurement strategy*
- smoking / non-smoking - *effect on biological monitoring*

Blanks & Duplicates

- split samples urine - *quality check lab*
- field blank 3M-badge - *quality check lab*

Questionnaire

- medication
- smoking behaviour
- PPE use
- Representativeness measurement day

Methods

Limit values

Parameter per medium	Occupation Exposure Limit (OEL)	Note	Reference value	Note
Benzene in air	3,25 mg/m ³ (1 ppm)	Legal OEL (NL)	-	-
t,t-muconic acid in urine (end-shift)	-	-	0,5 mg/gr creatinine	Upper limit non-occupational exposure
	-	-	2,0 mg/gr creatinine	Equivalent value for 1ppm air concentration

Reference values in urine derived from German *EKA-Wert*

Limit values of other solvents: EU / US / DE value if no legal OEL (NL)

Results

Measurements

		Study 1	Study 2
Year		2012	2013
Season		Winter	Summer
Average minimum and maximum daily temperature (in °C)		-0,3 - 4,3	15,8 - 24,7
# sampling days		9	13
# Air samples (3M + PID)	Operations	60	50
	Office employees (controls)	10	0
# Urine Samples (end shift)	Operations	60	50
	Office employees (controls)	10	0

Results

Personal air sampling - 3M-badge (8h-TWA)

- In large number of air samples no VOC detected (75% and 64%)
- In small number of air samples benzene detected (10% and 13%)

N (Study 1)	Measured benzene concentration (8h-TWA in mg/m ³)
1	Approx. 200% OEL
6	< 10% OEL
60 +	<i>Below LOD (< 0,07 mg/m³)</i>

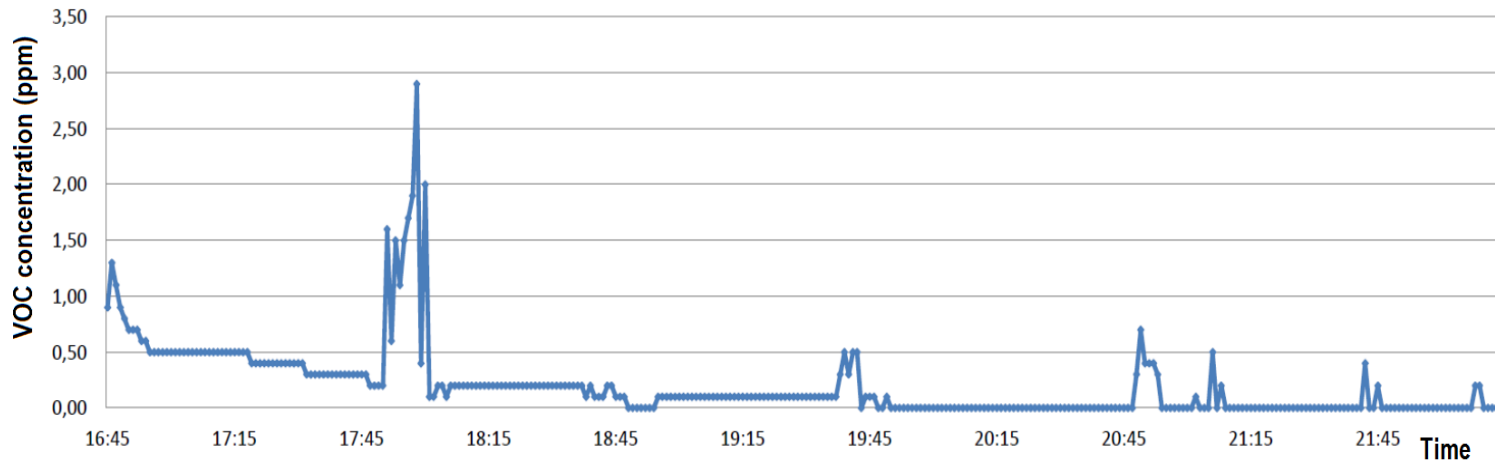
N (Study 2)	Measured benzene concentration (8h-TWA in mg/m ³)
1	64% OEL
5	< 10% OEL
40 +	<i>Below LOD (< 0,07 mg/m³)</i>

Legal OEL (NL) benzene = 3,25 mg/m³

Results

Personal air sampling – match 3M-badge and PID?

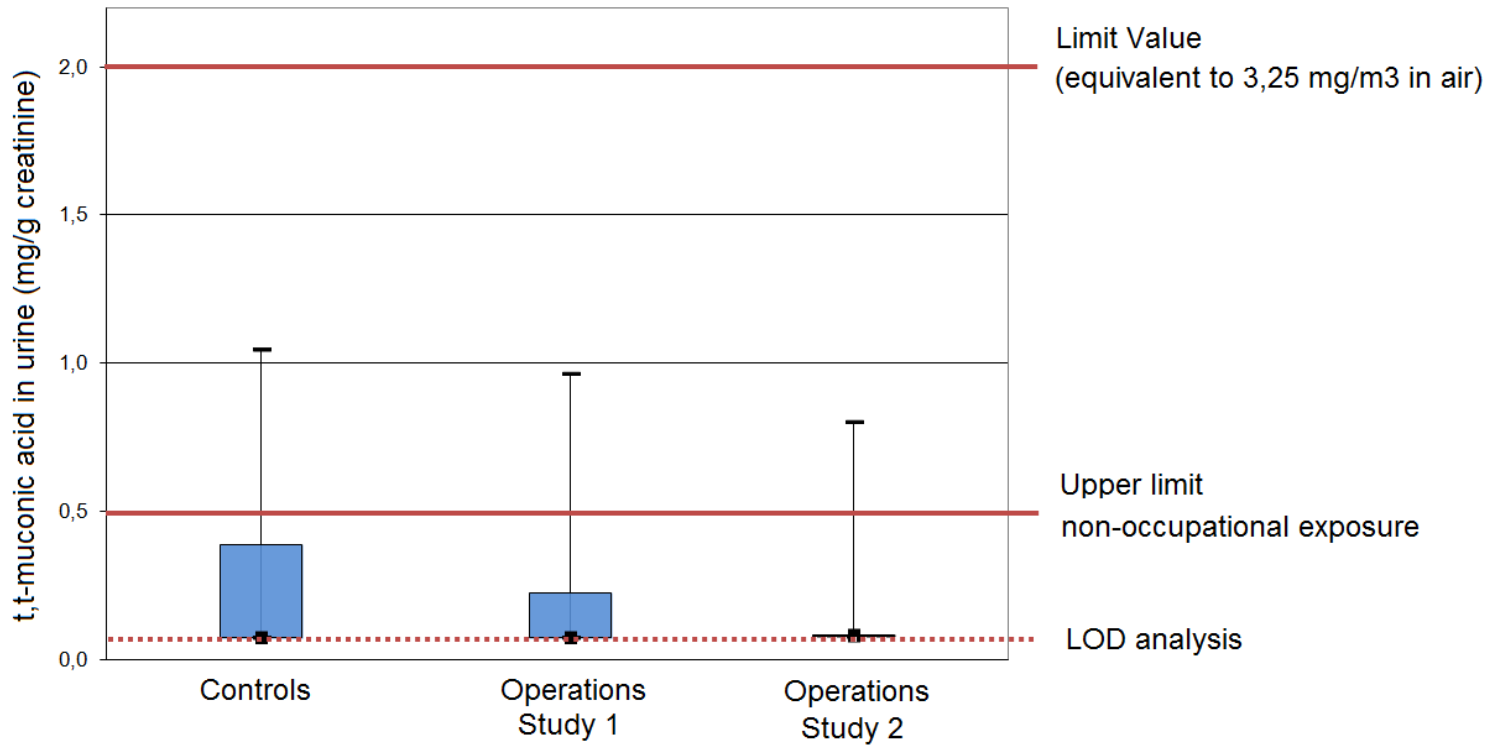
- One or more solvents detected (25% and 36%)
- 5 samples >LOD (<12% OEL)



- Task x with benzene, but task registration: 19:00 – 19:30h?
- PPE used

Results

Urine sampling (end shift)





		N	< LOD	AM	GM	GSD	min – max
Controls		9	6	0,32	0,19	2,72	0,08 - 1,04
Operations	Study 1	56	37	0,19	0,12	2,51	0,08 - 0,96
	Study 2	47	41	0,13	0,09	2,4	0,08 - 0,80

Results

Relationship between air and urine sampling (1)

Study 1



N	Measured benzene concentration	
	 Air (8-h TWA in mg/m ³)	Urine (t,t-muconic acid in mg/g CT) 
1	Approx. 200% OEL	< LOD
6	< 10% OEL	< LOD
60 +	< LOD	< LOD

- no correlation between air and urine concentration
- PPE offers sufficient protection (?)

Results

Relationship between air and urine sampling (2)

Study 2

N	Measured benzene concentration	
	 Air (8-h TWA in mg/m ³)	Urine (t,t-muconic acid in mg/g CT) 
1	64% OEL	40% BEI
1	5% OEL	18% BEI
1	5% OEL	24% BEI
2	< 10% OEL	< LOD
40 +	< LOD (< 0,07 mg/m ³)	< LOD

- correlation between air and urine concentration
- PPE used? / efficiency?

Wrap-up

Extensive study

Low external and internal exposure

Hard to retrace the exact cause of exposure

Not only about sampling; good task registration is indispensable

Any suggestions?

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Thank you for your attention!

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