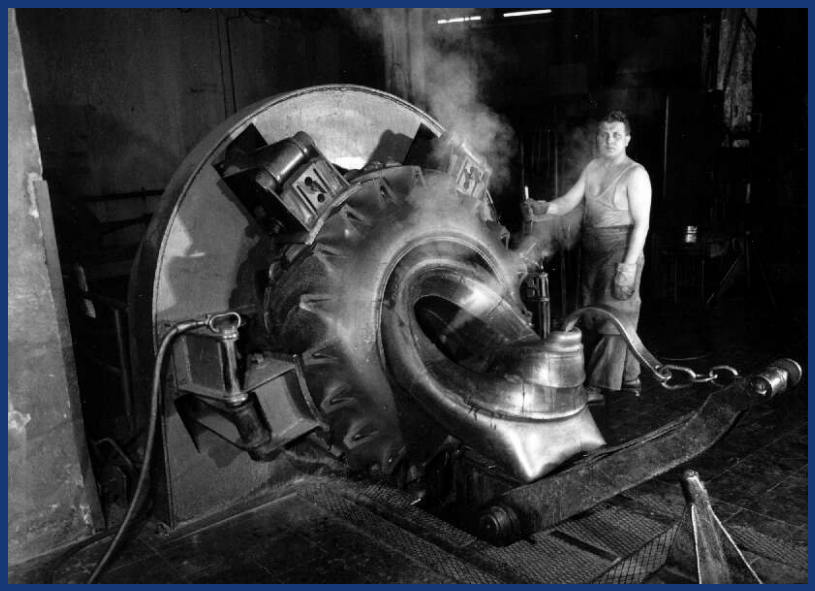
ExAs Rub

NVvA symposium 2005

Blootstelling aan N-nitrosamines in de Europese rubber industrie (1980-2003)



Improved Exposure Assessment in the Rubber Manufacturing Industry

F. de Vocht, R Vermeulen, I Burstyn, U Bergendorf, T Sorahan, W Sobala, M Heise, H Kromhout, namens het EU-EXASRUB consortium

http://exasrub.iras.uu.nl

EU-EXASRUB

QLRT-2001-02786

EU-EXASRUB database:

1. European Concerted Action in the 5th framework
2. Collect exposure data from the Rubber Industry in Germany, Netherlands, United Kingdom, Poland and Sweden.
3. Common method of exposure assessment
4. Exposure to a number of chemicals, but primarily *inhalable particulates, rubber fumes, N-nitrosamines and solvents.*
5. Measurements from 1965-2003

6. Enable the combined epidemiological analysis of prospective cohorts for remaining cancer risks in the industry

The Rubber Industry

ExAs Rub

Crude Materials
Mixing and Milling

Pre-treating

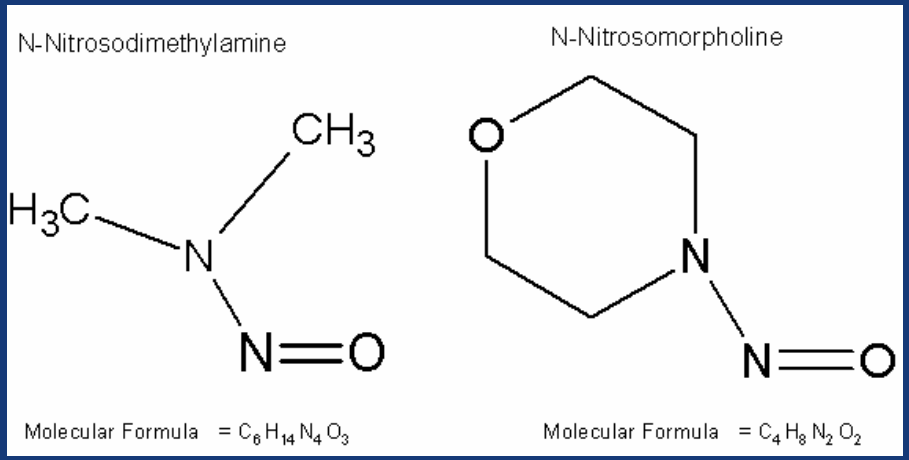
Curing

Post-treating and storage

Maintenance
Engineering

Non-process workers

Introduction: NDMA & NMor



- Evidence directly linking exposure to nitrosamines to cancer in humans difficult to establish:
  - exposure to low concentrations
  - part of complex mixtures

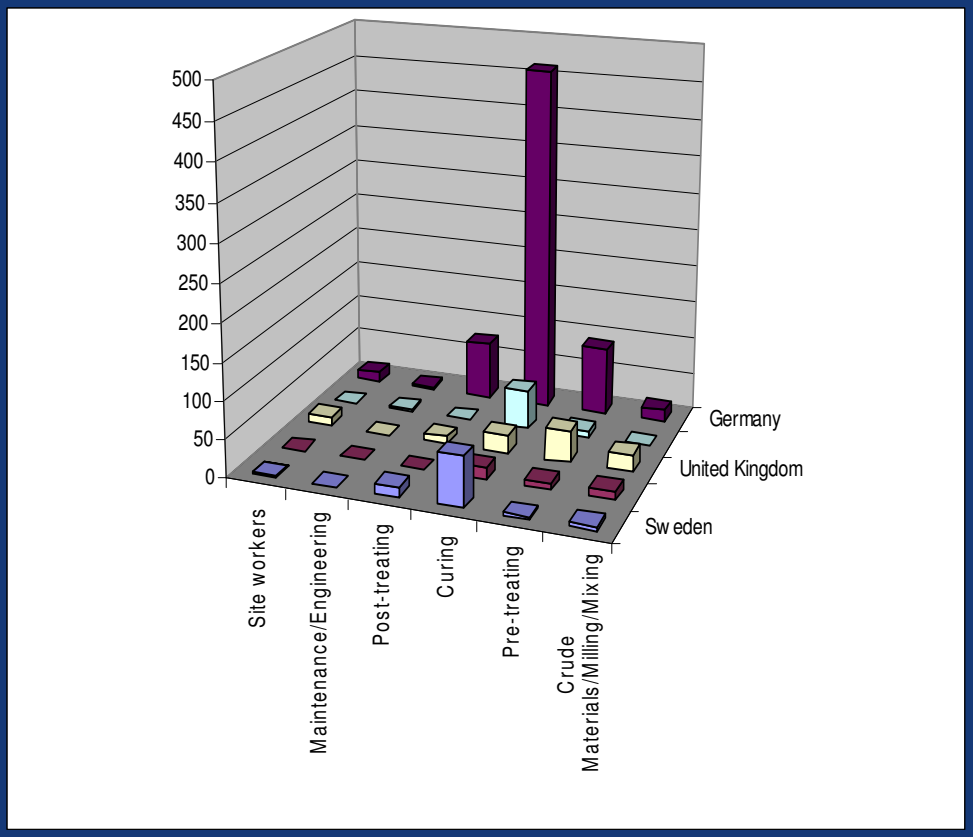
- Straif *et al.*, 2000 have linked exposure with cancers of the oesophagus, oral cavity and pharynx, but not with cancers of the stomach and lung.

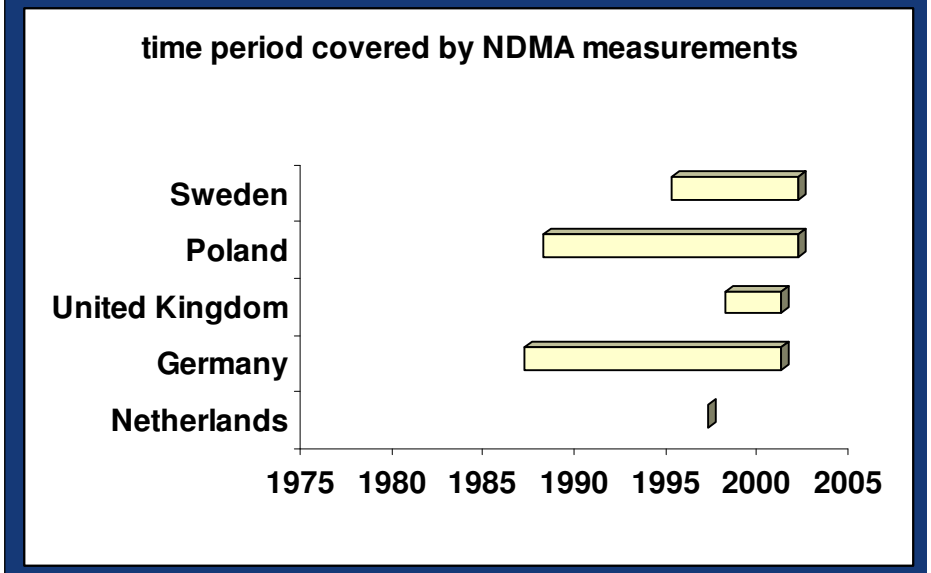
- The highest concentrations in the human environment have been measured in the rubber industry

N-Nitrosamines Measurements

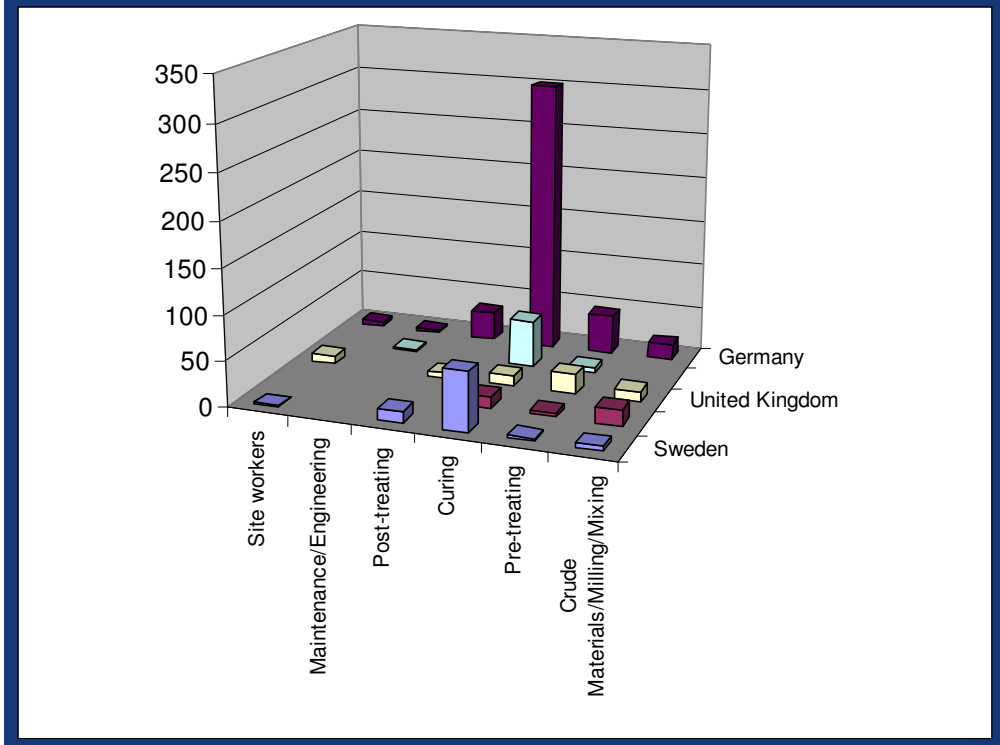
	NDMA	NDBA	NDEA	NMOR	NDPA	NEPA	NMPA	NPYR	NPIP	NMEA	Total
Netherlands	97	66	88	97					47		
Germany	1961	1959	1959	1959	1959	1959	1988	1959	1959		957
United Kingdom	84	84	84	84					84	84	84
Poland	45	45	45	45	35			35			
Sweden	132	131	131	131	131			131	131	131	131
>LOD	60%	10%	13%	43%	14%	2%	34%	13%	17%	56%	79%

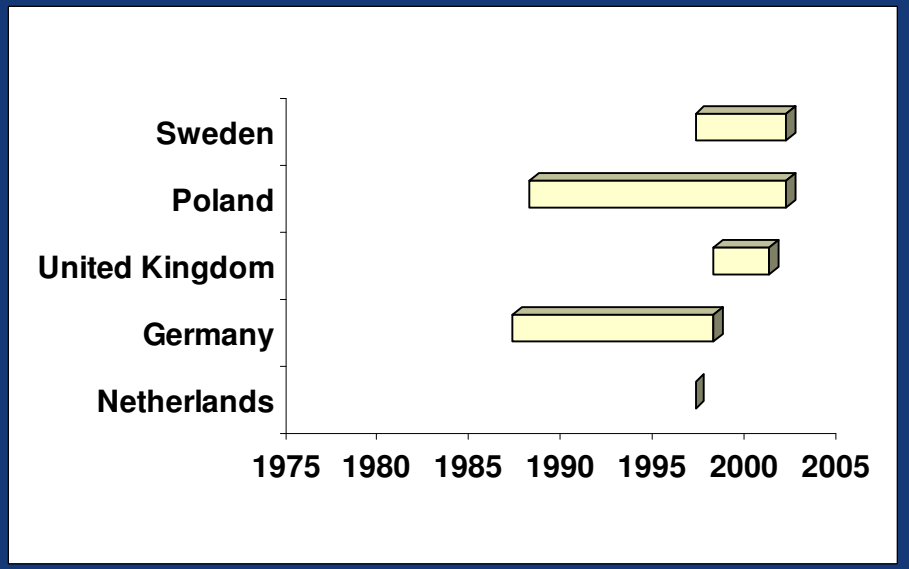
NDMA - Distribution of measurements





NMor – distribution of measurements





Statistical analyses: mixed effects model

$$Y_{ij}=\beta_{00} + \beta_{10-x0}{}^{*}X_{1-x} + b_{factory} + \varepsilon_{ij}$$

Y_{ijk} = log(concentration) in $\mu g/m^3$ for measurement(i) of employee(j) in factory(k)

for the curing departments and post-treating departments only

determinants

NDMA	NMor
country	country*sampling method
sampling method (personal, stationary,source-oriented)	
sampling time	sampling time
industrial sector (tyres vs. GrG)	industrial sector
salt bath curing	-

timetrend

per country	per country

Statistical analyses: logistic regression

$$\text{Logit}_{(lod)} = \beta_0 + \beta_{1\text{-}x} + \varepsilon_i$$

Logit$_{(lod)}$=likelihood of measuring a detectable concentration

determinants

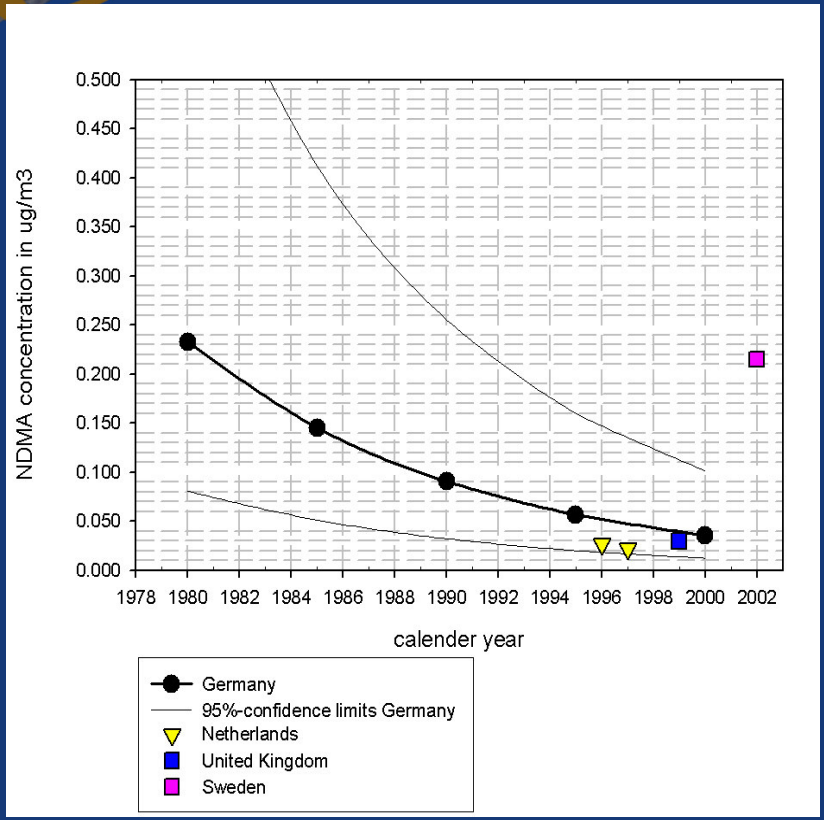
NDMA	**NMor**
country	country
sampling method (personal, stationary,source-oriented)	sampling method
department	department
salt bath curing	salt bath curing
purpose of survey	

timetrend

absent	general

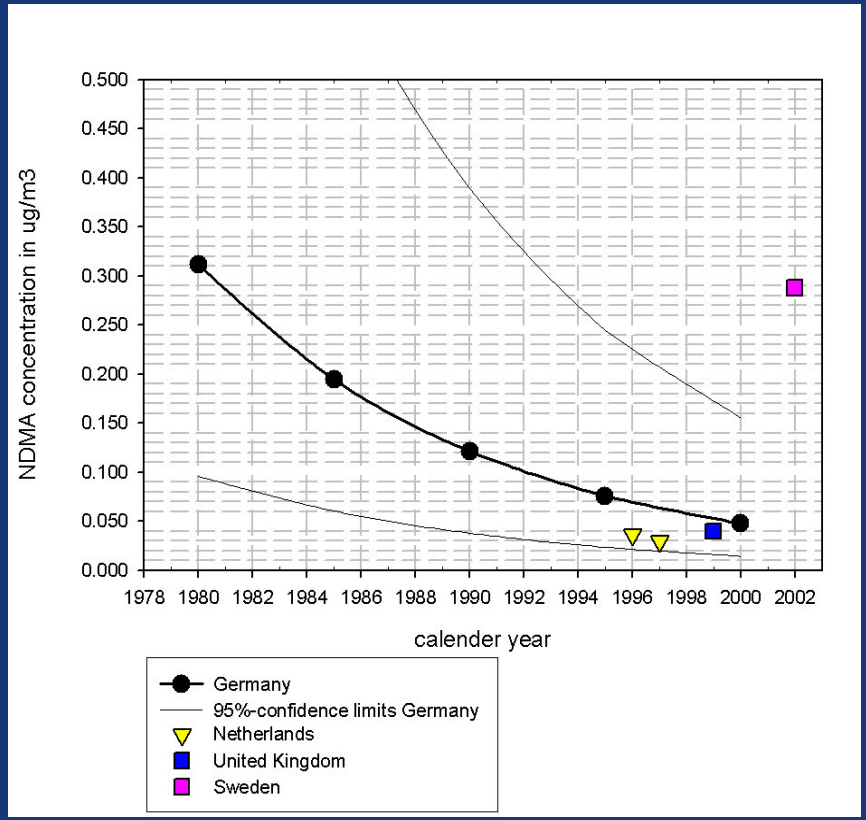
Results NDMA: Average personal exposure

production of tyres



47% than production of GrG

production of GrG: salt bath curing



34% than production of tyres

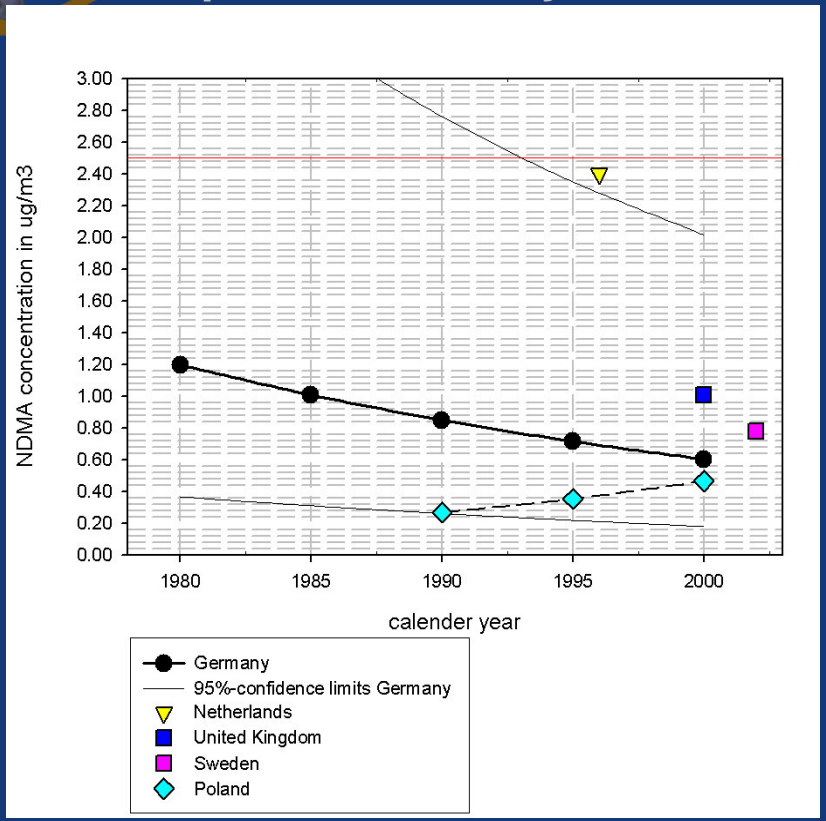
- time trend Germany –9%/year
- Swedish data from small survey by labour inspection

Results NDMA: detectable concentrations

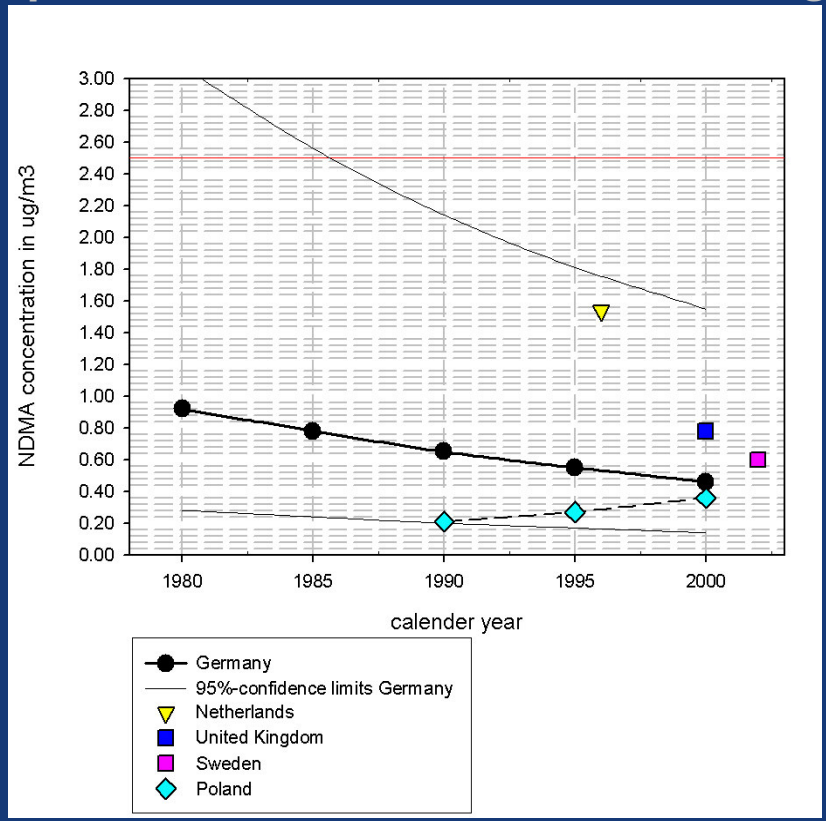
determinants		Odds ratio [95% CI]
country	**Netherlands**	**68.53 [8.92 – 526.29]**
	Sweden	3.04 [0.71 – 13.04]
	United Kingdom	0.66 [0.41 – 1.06]
	Poland	1.21 [0.22 – 6.75]
	Germany	1.00
department	site worker	0.83 [0.48 – 1.44]
	maintenance	0.71 [0.18 – 2.86]
	post-treating	**0.70 [0.52 – 0.93]**
	pre-treating	0.83 [0.61 – 1.11]
	crude materials	**0.44 [0.28 – 0.70]**
	other curing	1.00
	salt bath curing	**8.38 [2.96 – 23.73]**
sampling methods	personal	0.11 [0.00 – 9.68]
	stationary	**0.46 [0.38 – 0.56]**
	source-oriented	1.00
purpose of survey	**research**	**0.07 [0.01 – 0.28]**
	evaluation controls	**0.05 [0.00 – 0.67]**
	compliance companies	**0.04 [0.02 – 0.09]**
	concern	>999
	compliance by regulator	1.00

Results NMor: Average personal exposure

production of tyres



production of GrG: salt bath curing



- 20 % higher during the production of tyres than of GrG
- No sign. higher exposure during salt bath curing
- Exposure in Netherlands higher than in other countries (small (worst-case) survey labor inspection)

Results NMor: detectable concentrations

determinants		Odds ratio [95% CI]
country	Netherlands	23.29 [10.74 – 50.52]
	Sweden	<0.001
	United Kingdom	2.15 [1.12 – 4.14]
	Poland	<0.001
	Germany	1.00
department	site worker	1.07 [0.57 – 1.98]
	maintenance	0.25 [0.05 – 1.40]
	post-treating	0.71 [0.51 – 0.98]
	pre-treating	0.46 [0.32 – 0.64]
	crude materials	0.63 [0.37 – 1.08]
	other curing	1.00
	salt bath curing	3.99 [1.27 – 12.52]
sampling methods	personal	-
	stationary	0.72 [0.58 – 0.90]
	source-oriented	1.00
purpose of survey	research	>999
	compliance companies	0.26 [0.12 – 0.54]
	compliance by regulator	1.00
general time trend		0.86 [0.83 – 0.89]

Conclusions

- Estimated concentrations comparable across Europe, but higher in Sweden (NDMA) and Netherlands (NMor) due to small (worst-case) labor inspection surveys.

- Average exposure still highest during salt bath curing:
  - 47% average exposure (NDMA)
  - 8-times (NDMA) and 4-times (Nmor) more detectable conc.

- Average personal exposure to NDMA and NMor reduced with 9% and 3% per year in Germany to well below OELs, but not an elimination.

- In contrast to NDMA-exposure, has exposure to low concentrations of NMor been reduced as well (-14%/year)

EU-EXASRUB consortium

F Baarslag†
KH Bedemann
U Bergendorf
I Burstyn
A Dost
L Hagmar
M Heise
K Jakobsson
H Kromhout
L Nichols
B Peplonska
W Sobala
T Sorahan
K Straif
K Straughan
P Swuste
N Szeszenia-Dabrowska
D Taeger
R Vermeulen
F De Vocht