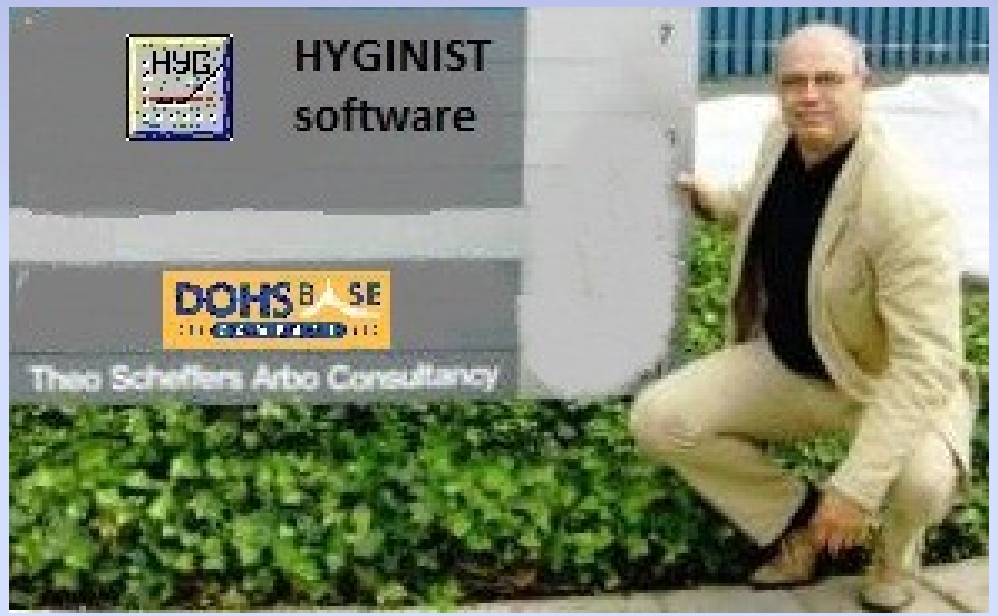

# Statistics and Representative measurements

SOPHYT Lille Forum 2016
Theo.Scheffers@tsac.nl

# theo.scheffers@tsac.nl

Consultant chemical exposure assessment & control

Software developer Hyginist, DOHSBase, BW_Stat

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# Statistics & Representative measurements

- Statistics is a scientific trick
  - Garbage in (delivered by you!!) => garbage out
- Collecting representative measurements is an art
  - Skills
  - Experience
  - Observation
  - Analyse
  - Communication

# Different scenarios

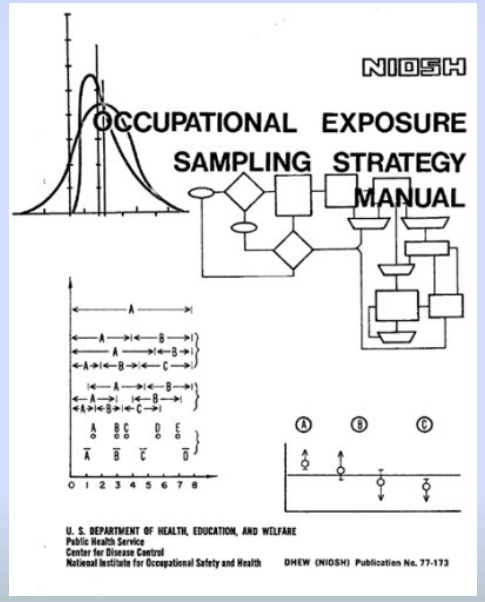
Workshop

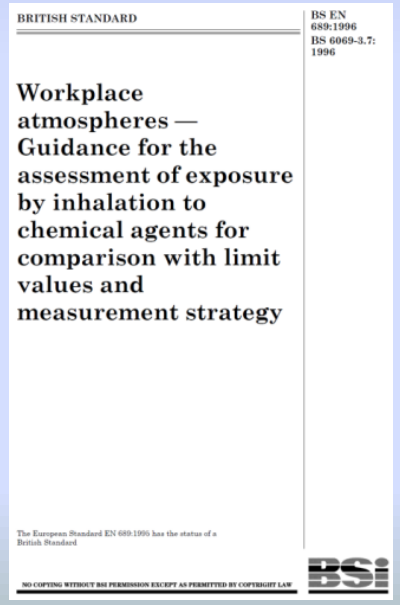
Representative measurements for OELV testing should reflect:

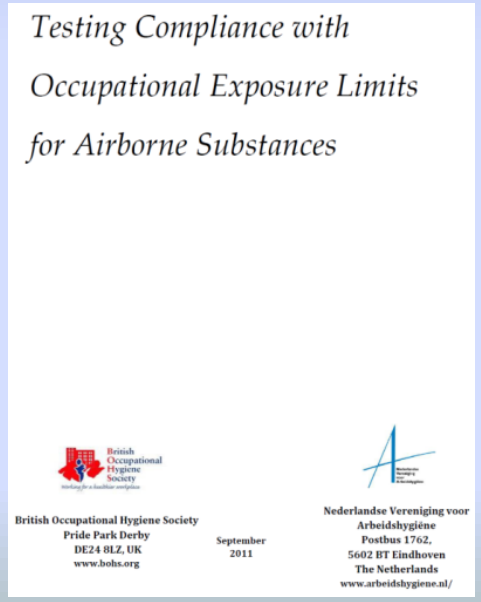
1. SEG exposure variability in space and time
2. the legal limit reference period specific exposure of an individual worker
3. Worst case
4. SEG long-term average exposure level
5. Task specific workers safe exposure

# Struggling with representativeness, small sample sizes and exposure variability

1977 1995 2011 2016




prEN 689
Next speaker
Roger Grosjean

# EN 689 Screenings test

| Decision 5.5.2 | Compliance | reassessment | Non-compliance |
|---|---|---|---|
| Sample size N | All outcome < f*OELV | Otherwise | Outcome > OELV |
| 3 | f=0.1 | | ≥ 1 |
| 4 | f=0.15 | | |
| 5 | f=0.2 | | |

Evidence based for GSD≤3 : INRS (2005) ND2231

# Exercise 1

- Exposure profile/scenario: Operator filling bags
- 3 gravimetric 8 hr PAS measurements : 0.45, 0.4 and 0.45 mg/m$^3$
- $CV_t$=25% (EN 482, coefficient of variation)
- OELV: 5 mg inhalable/m$^3$
- Compliance  or  ?
- Representative measurements?
- GSD=1.07 ! 
  - small sample error, autocorrelation
  - evaluate SEG/sampling plan => resample N≥3

| Decision 5.5.2 | Compliance | reassessment | Non-compliance |
|---|---|---|---|
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# Excercise 2

Workshop

- Three solvent measurements 0.01; 0.3 and 9.9 ppm
- Professional spray painting
- Solvent OELV: 100 ppm
- Compliance  or  ?
- Exposure range of 3 orders of magnitude (GSD=31)
- Representative for professional spay painting?
  - Read across (next slide)
  - If no, then improve SEG/sampling => resampling N≥3
  - If yes, then (not in standard) => additional sampling up to N≥6

# Painters GSD, read-across Annals 1985

| Type of object | Number of painters* | Types of paint | Remarks |
|---|---|---|---|
| 1 Apartment building | 6 | Chlororubber paint | |
| 2 Ambassador's house | 4 H | Synthetic wall paint, prime colour varnish | |
| 3 Telephone district centre | 3 H | Alkyd resin, latex wall paint, synthetic wall paint | |
| 4 Brewery | 4 | Synthetic wall paint, 2-component epoxy resin | |
| 5 Furniture showroom | 6 H | Alkyd resin | Spraying by 1 painter |
| 6 Canteen | 4 | Structure wall paint, alkyd resin | Spraying by 1 painter assisted by 1 colleague |
| 7 Room of regents in Lower House residence | 4 | Turpentine paint | Only 2 painters were sampled |
| 8 Garage | 5 H | Latex wall paint, synthetic wall paint, 2-component varnish | |
| 9 Pumping station | 4 | Chlororubber paint | During only a few minutes were protective clothes with air refreshment worn |
| 10 Laboratory | 2 H | Synthetic wall paint | |
| 11 Laboratory | 3 H | Varnish, alkyd resin | |
| 12 Distributing station | 2 | 2-component polyurethane lacquer | Spray-painting was performed during several minutes |


| Painter group | Number of painters ($n$) | Tolerance factor $k_7$* | Log normality $P$† | Geom. mean GM‡ (mg m$^{-3}$) | Geom. stand GSD§ |
|---|---|---|---|---|---|
| House painters | 20 | 2.752 | 0.85 | 58.66 | 2.086 |
| Total group | 45 | 2.408 | 0.38 | 100.9 | 2.673 |
| House painters | 20 | 2.752 | 0.50 | 0.15 | 1.936 |
| Total group | 45 | 2.408 | 0.04** | 0.28 | 2.648 |

# Exposure variability

- Compare your GSD with the typical variability for the exposure profile tested:
  1. measurement series performed before
  2. GSDs reported in large databases like the French COLCHIS and the German MEGA
  3. literature
  4. Read across with comparable substances and workplaces

# Initial Assessment – Testing Compliance with OELvs

- Statistical test : ≥ 6 results
  - The test shall measure, with at least 70% confidence, whether less than 5% of exposures in the SEG exceed the OELV

  - $C_{95\%,70\%}$ < OELV **Compliance**
  - $C_{95\%,70\%}$ > OELV **Non-Compliance**

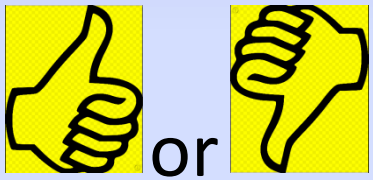
# Exercise 3

- ≥ 6 measurement in a clean room
- GSD=2
- $CV_t$=5%
- $C_{95\%,70\%}$<OELV

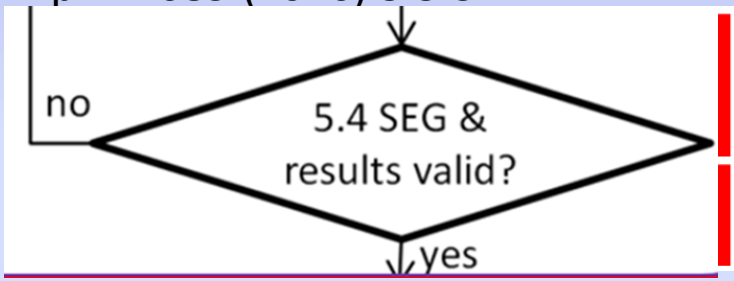
prEN 689 (2016) 5.5.3


- 5.5.3. Compliance!
- Is the GSD representative for clean room?
  - Evaluate controls => resampling N≥3
  - Evaluate between worker differences (N≥2*3)

# Exercise 4

- ≥ 6 measurement outdoor painter, solvent exposure
- GSD=1.4
- $CV_t$=5%
- $C_{95\%,70\%}$<OELV
- Compliance  ?

prEN 689 (2016) 5.5.3




Is a GSD=1.4 representative for this exposure scenario?

- evaluate SEG & sampling plan

# Exposure variability

- Underestimation of GSD's is caused by:
  - one day sampling.
  - small sample size
  - sloppy handling of non-detectables
  - autocorrelation (one outcome determines the next)
  - 2-decades analytical detection methods (like gravimetric dust and inorganic acid sampling)
  - EM in stead of PAS
- Use your expertise (and prEN 689 chapter 5.1 through 5.4 )!
- For workplace GSD≤3, between-worker differences may become relevant: individual exposure testing

# No two workers are exposed exactly the same

2011

*Testing Compliance with Occupational Exposure Limits for Airborne Substances*

Testing between worker differences

British Occupational Hygiene Society

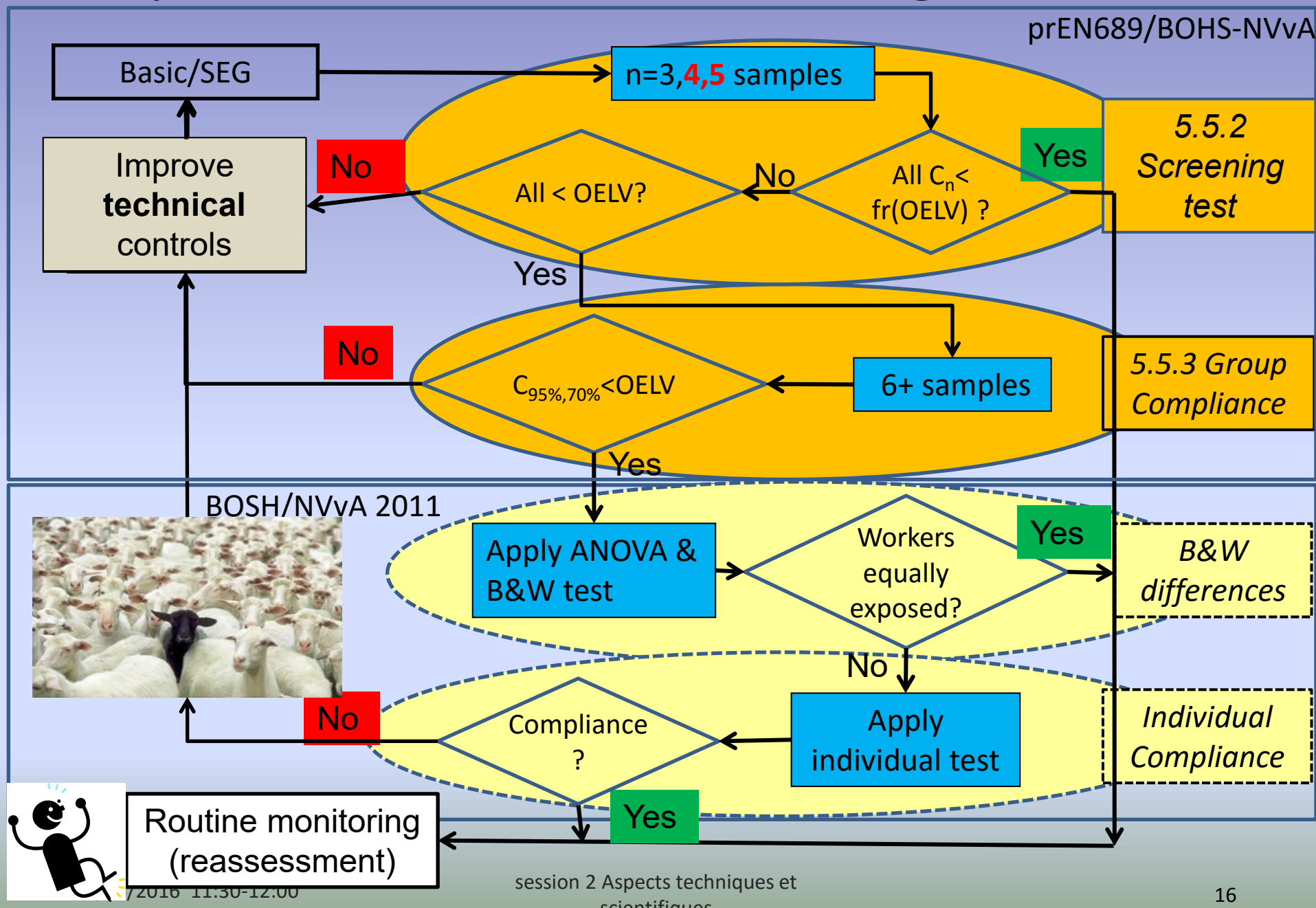
British Occupational Hygiene Society
Pride Park Derby
DE24 8LZ, UK
www.bohs.org

September
2011

Nederlandse Vereniging voor Arbeidshygiëne
Postbus 1762,
5602 BT Eindhoven
The Netherlands
www.arbeidshygiene.nl/

But are their differences within a well defined exposure group relevant ?

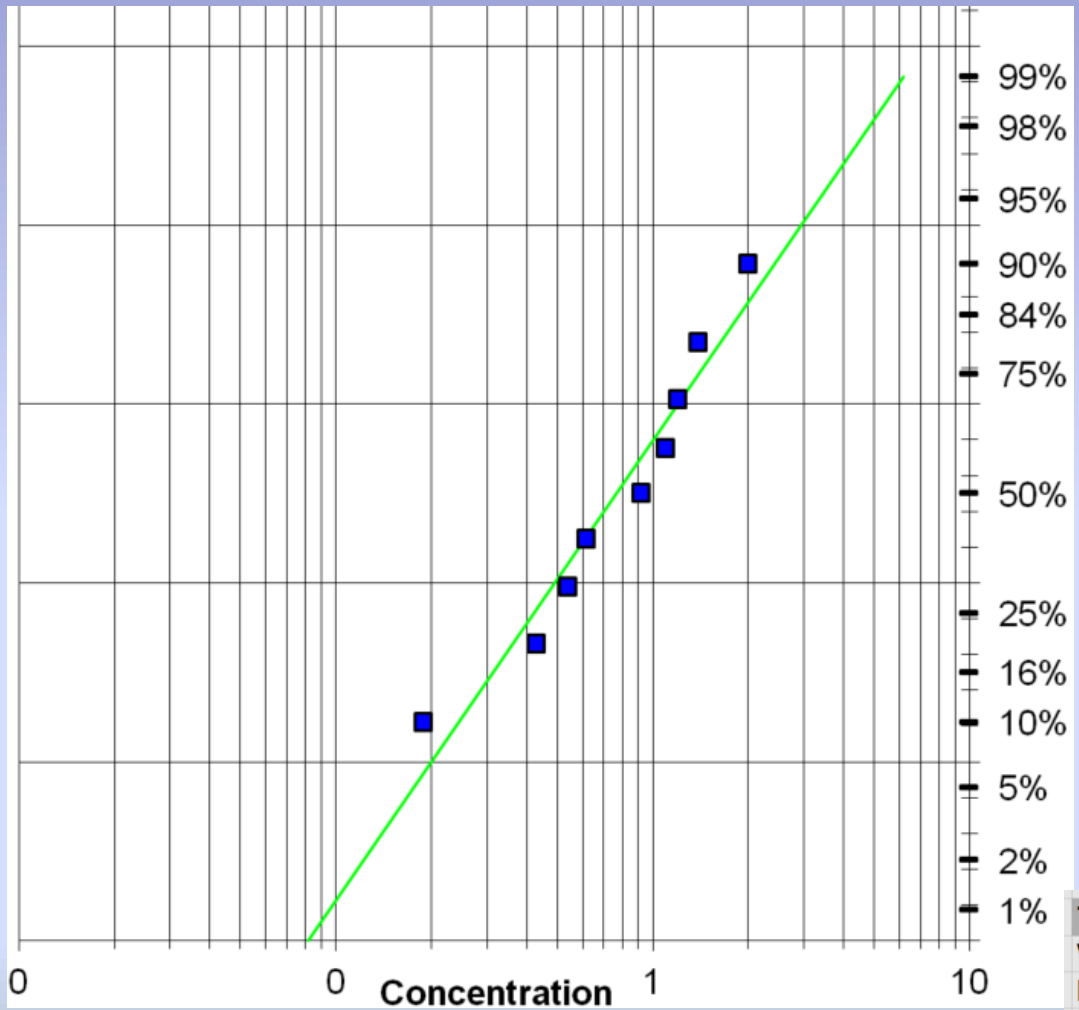
# prEN 689/NVvA-BOHS testing scheme



# Between Worker Variability in SEG

- Becomes apparent if long-term day-by-day GSD<3
- Linked to well-controlled (“clean room”) or fix tasks exposure scenarios
- May stigmatize workers as “dirty”, incorrectly if individual sample size is small (<6)

# Lognormal probability Exercise 5

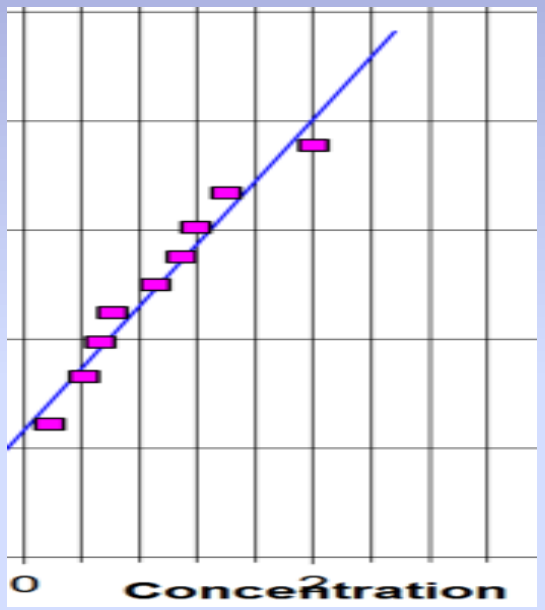


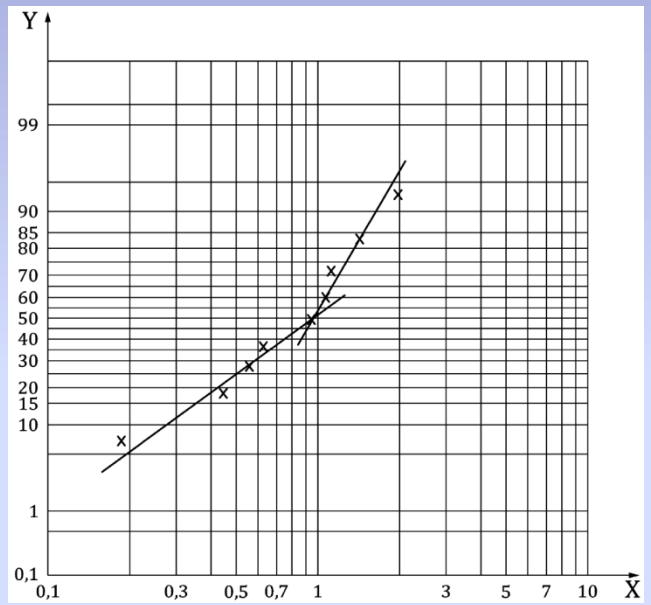

Example
Annex E , figure E.2
IH-Stat plot
N=9 dust samples
Range .2 to 2 mg/$m^3$
GSD=2.045

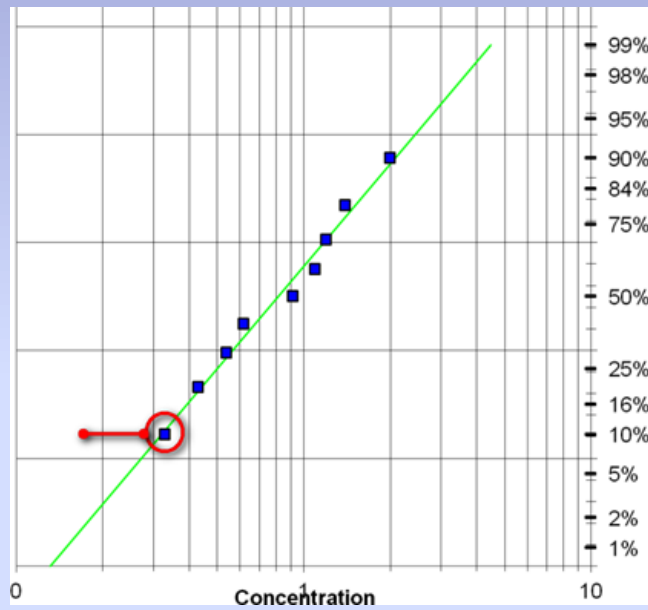
| TEST FOR DISTRIBUTION FIT | |
|---|---|
| W-test of logtransformed data (LN) | 0.958 |
| Lognormal (a = 0.05)? | Yes |
| | |
| W-test of data | 0.964 |
| Normal (a = 0.05)? | Yes |

Workshop

# A little bit of lying with statistics




CVt Normal?

2 lognormal distributions?

one inaccurate low value?

Not the statistics, but the exposure determinants (5.1 through 5.3) will tell!

Become a representative measurement expert!
Let BW_stat do the statistics

Theo.Scheffers@tsac.nl

Theo.scheffers@dohsbase.nl