LONDON 2015
IOHA 10th IOHA International Scientific Conference

Compliance testing

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Agenda

1. Compliance
2. NVvA/BOSH compliance testing scheme
3. Lognormal goodness-of-fit
4. Processing undetectables
5. GSD values

manage exposure in the workplace

Workplace survey & compliance testing

This is the bit we are talking about

Workplace survey

I. Basic characterization
II. Choosing the best OEL
III. [Workplace air sampling]
IV. Compliance testing
   - Dealing with uncertainty (Jérôme)
   - BOHS-NVvA approach (this sesion)
   - Other approaches/tools (Jerome 15:45)

BOHS-NVvA approach

- Compliance
- BOHS-NVvA testing scheme
- Lognormal goodness-of-fit
- Processing undetectables
- GSD values

Not included: Bayes, Optimize sample size

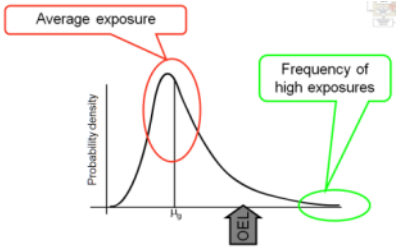
Compliance means that OEL exceedance =:

Working Conditions law enforcement (EU)

- Zero, TWA/STEL/C in workplace air

REACH (EU) per task short/long term :

- Excluded, modelling.
- 95, 70%, measurements (ART)
  - behind RPE only for local/acute effects?



Industrial Hygiene perspective:

- P < 5 % of all reference periods (NIOSH, 1977)
- $P_{\text{group exceedance,70\% confidence}} < 5\ \%$ (BOHS-NVvA/France), with $P_{\text{individual exceedance in SEG}} < 20\ \%$ (BOHS-NVvA)

Polling. I need to guarantee compliance:

A. At the premises (space and time)
B. In the breathing zone (space and time)
C. For all tasks performed (breathing zone)
D. Behind the RPE
E. In all similar exposure groups (SEG), for the reference period of the OEL
F. As D, including the individual workers in a SEG

To which option do you feel atracted ?

Structure of the BOHS/NVvA guidance

1. Form Similarly Exposed Groups (SEGs)
2. Preliminary test **Three measurements per SEG** to eliminate groups that obviously comply or obviously fail.
3. Test *group compliance:* **≥6 more measurements per SEG**

   Based on ≥ 9m measurements, the group complies if, with 70% confidence, <5% of the exposures in the SEG exceed the OEL
4. Do analysis of variance to see if individual differences are important.
5. If so, test *individual compliance*
   80% of the workers in the SEG must have <5% of their exposures >OEL

NVvA-BOHS testing scheme

Form SEG

Take 3 samples

All < 0.1 x OEL?

No

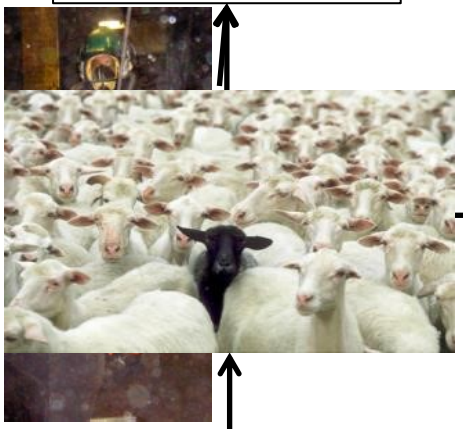
Any > OEL?

Yes

Improve controls

Yes

Stage 0 Screening test



No

Take 6+ more samples. Apply French test to 9+

Complian ce ?

No

Stage1 Group Compliance

Yes

Apply ANOVA & B&W test

Between-worker dif-ferences?

No

Stage 2 B&W differences

Yes

Apply individual test

Complian ce ?

No

3 Individual Compliance

Yes

Routine monitoring (reassessment)

BOHS The Chartered Society for Worker Health Protection

Stage 0: Why 3 samples & <0,1 OEL?

Combination of

1. Exposure variability increased
2. Work is more complicated (multiple task)
3. Arbitrary

Stage 1:
Why 6 additional when>0,1 OEL?

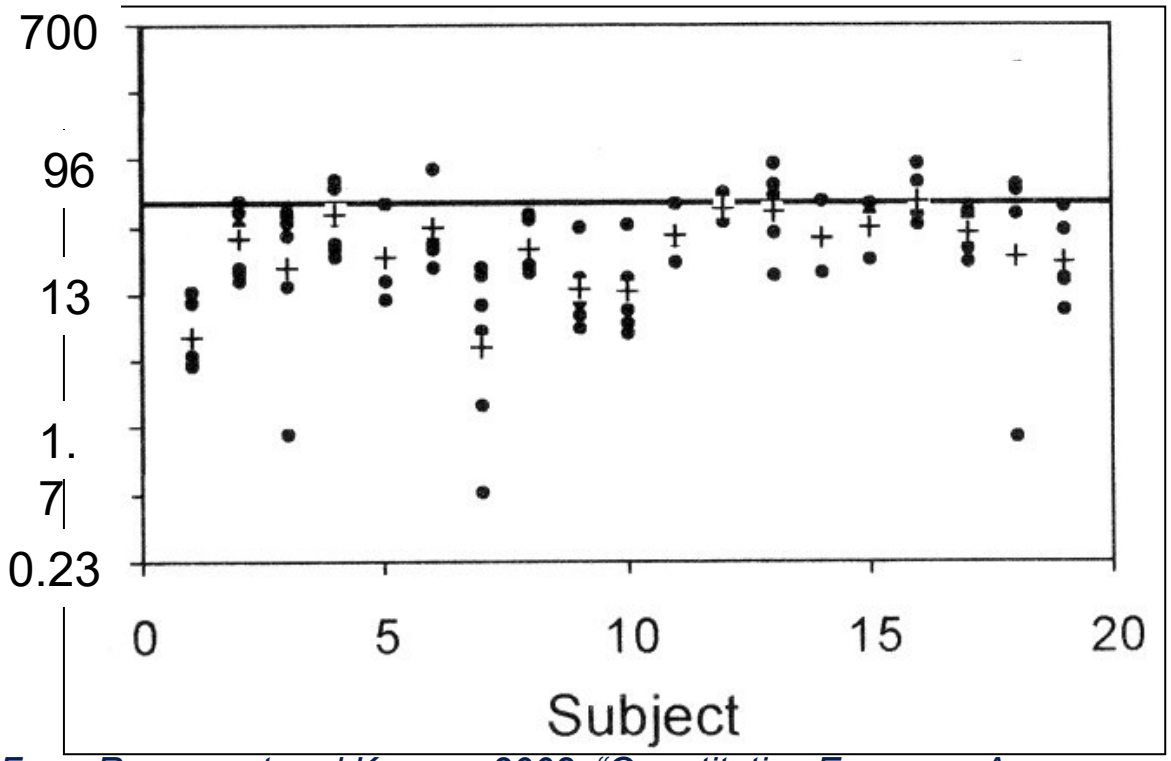
- Arbitrary
- French legislation
- Statistical power $P(C_{TWA}>OEL_{TWA})_{70\% \text{ confidence}}< 5\%$

Stage 2:
Why sample different workers in SEG?

- Dispute since the 90ties
- No 2 worker are the same

Kromhout 2007 BOHS presentation stressing the importance of including the individual compliance in a compliance testing guidance

B&W differences in location GM: Real or artifacts?

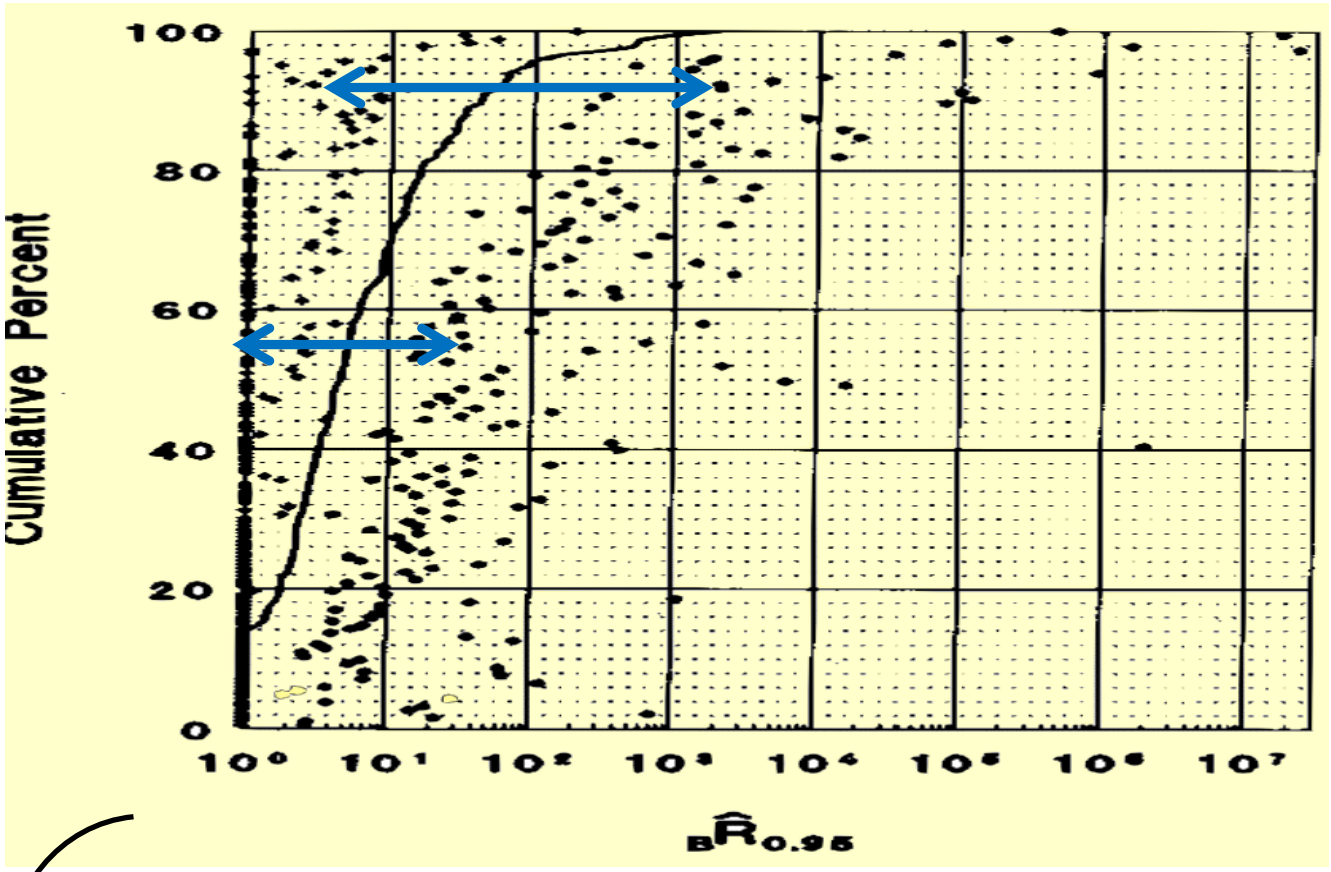


From Rappaport and Kupper, 2008, "Quantitative Exposure Assessment", ISBN 978-0-9802428-0-5, www.lulu.com

Most important addition NVvA-BOHS: Introduction of individual compliance testing

If the between-worker variation within a SEG makes an important contribution to the total variation, it is necessary to test individual compliance.

Between worker $_{B}R_{0.95}$ = ratio of 95% upper & lower **mean** (BW) Rappaport/Kromhout (1993)

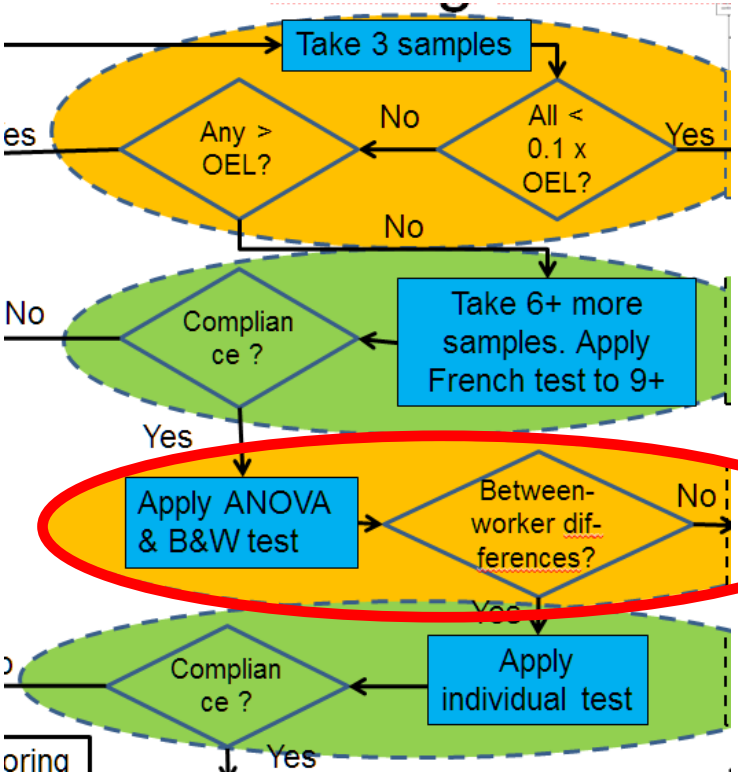


- 85% SEGs $_{B}R_{0.95}$> 2: large BW variability
- With confidence intervals ≤ 30% SEG significant BW differences
- Short-term sampling campaigns may cause non-existing BW differences
- 5% significant BW differences due to chance

[The studies provided limited/no evidence that BW is important]

Between & within worker variability and individual compliance

- Included in the BOHS-NVvA Guidance
- Relevance is tested before application
- Time must show its additional value



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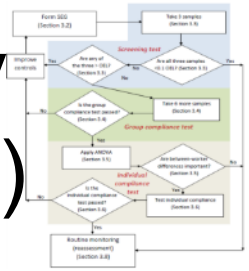
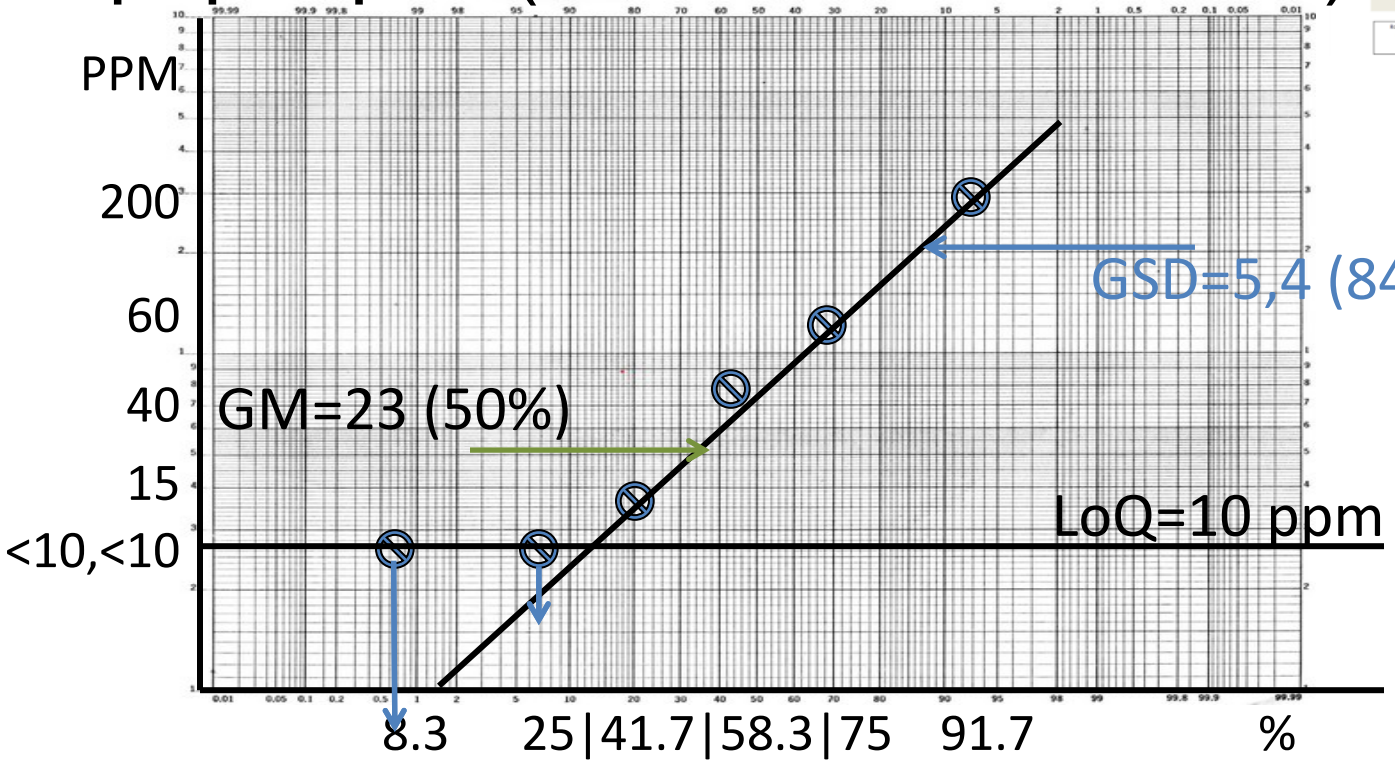
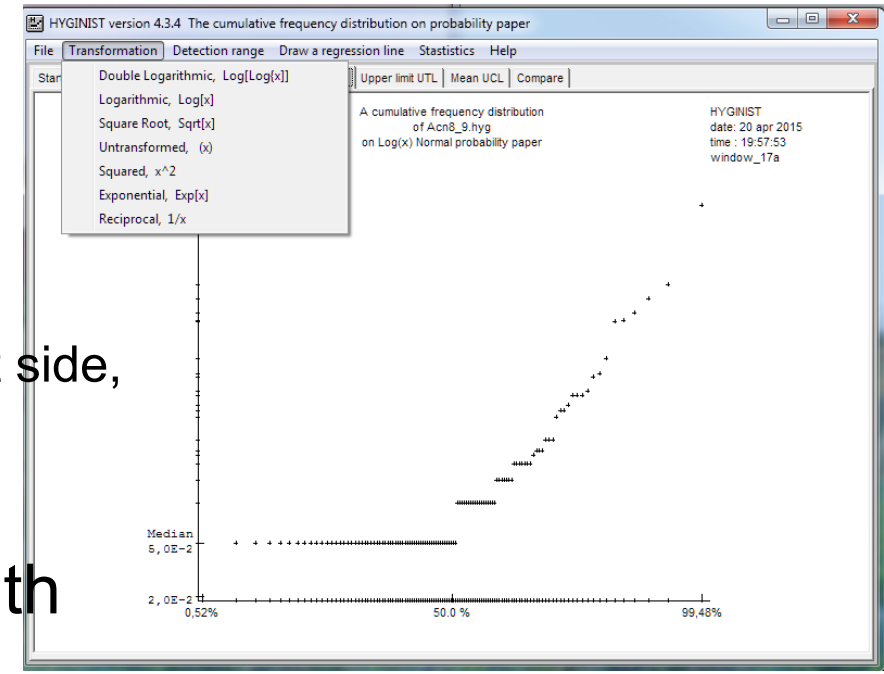
Goodness-of-fit using probability paper plot (incl. non-detectables)





Goodnes-of-fit inference tests

- Shapiro & Wilks the most powerful among the omnibus Goodnes-of-fit tests
- Too powerful for Industrial Hygiene?
  - behaviour in tails:
    - C_saturated for vapors at the right side,
    - Backgroud levels at the left
  - Analytical limitations
- Compare log-normal P(SW) with other transformations !



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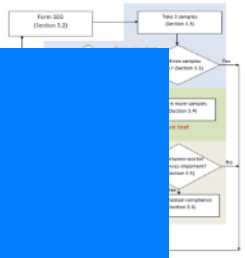


Estimating GM and GSD from sampling data with undetectables

Regression through the data above LoD and optimizing GM and GSD using Shapiro & Wilks Goodness-of-Fit

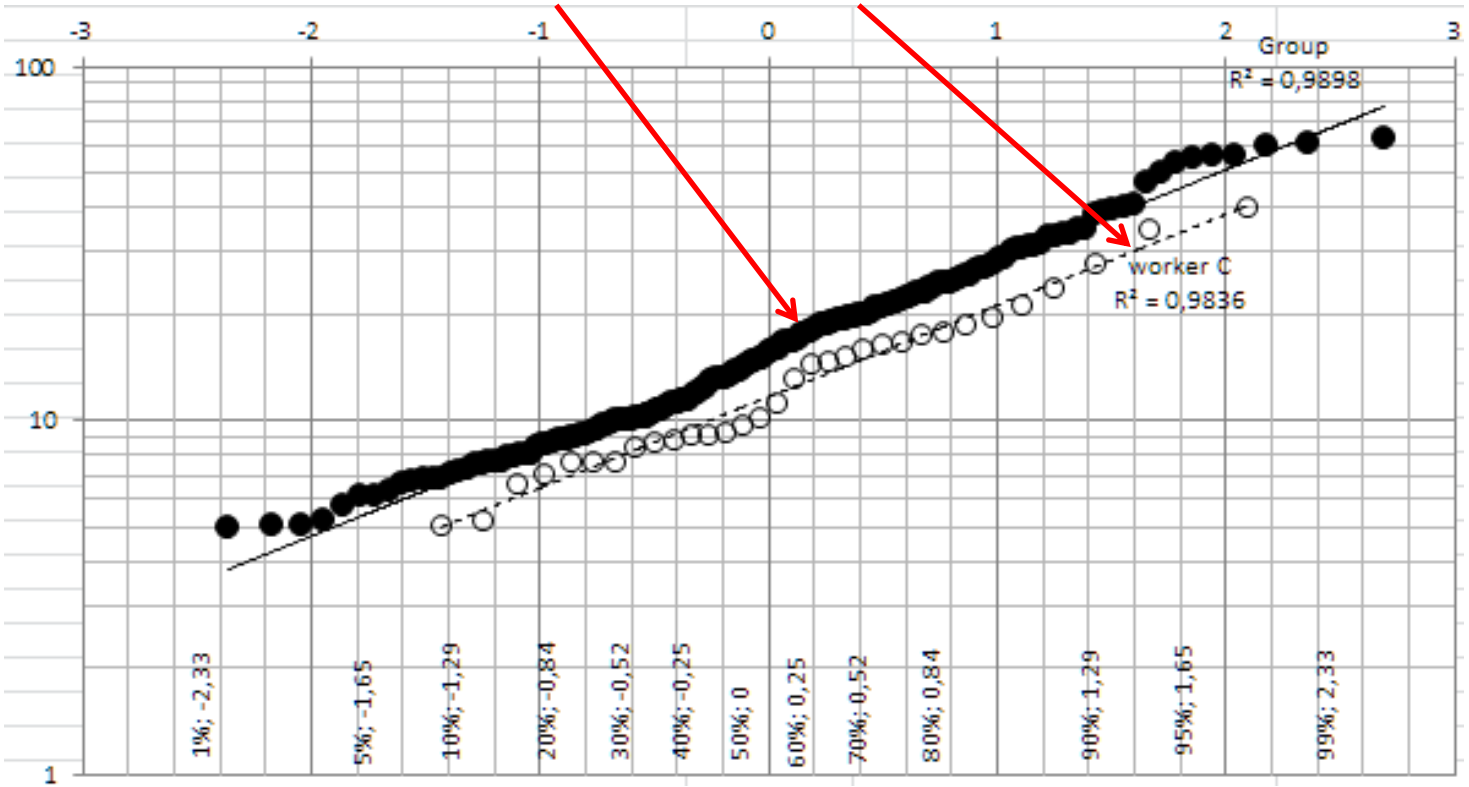
HYGINIST 4.2.3

Non-detects in Industrial Hygiene

- BOHS-NVvA guidance: “It is not recommended simply to substitute LoQ/2 or LoQ/√2 for each value<LoQ”
- Annals Occupational Hygiene (2009-2010) presented several large sample size solutions:
  - Ogden. Editorial: Handling results below the level of detection.
  - Helsel. Incorporating Non-detects in Science.
  - Flynn. Analysis of censored exposure data by the Shapiro-Wilk W statistic.

NVvA BOSH guidance
3.7 Treatment of values < LoQ

- “There are ML, regression & Shapiro & Wilks methods.”
- Included in BW_Stat for group and individuals



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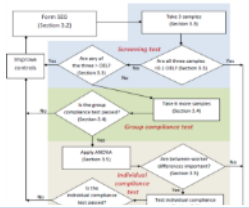
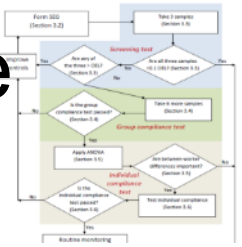
GS's in the real world



GSD	range $UTL_{95\%}$: $GSD^{\pm 1,64}$	Orders of magnitude	Comment, reference
<1,3	0,6-1,5	<1	CV_t. Indoor, well controlled. High background
2	0,3-3	1	Leidel 1977
2,7	0,2-5	1^+	Median, Buringh 1991
<3	0,15-6	2-	Poor SEG, AIHA IHStat
5,1	0,06-15	3^+	Median, Scheffers 2000
17	0,01-100	5	95%, Scheffers 2000

Why GSD is underestimated in workplace survey & OEL compliance control



- Small sample size: series of 2 to 6 underestimate the GSD on the ave
- Short sampling program during on
  - autocorrelation and underestimation
- Sampling during a selected part of
- Focus on one task (ignoring other
  - in a REACH exposure scenario
  - assessing a single combination of O Risk Management Measures (RMM)
- 2-decades analytical detection me and inorganic acid sampling)
- Sloppy handling of non-detects (Lo
- Use of old-time data (databases) w per shift
- High background levels

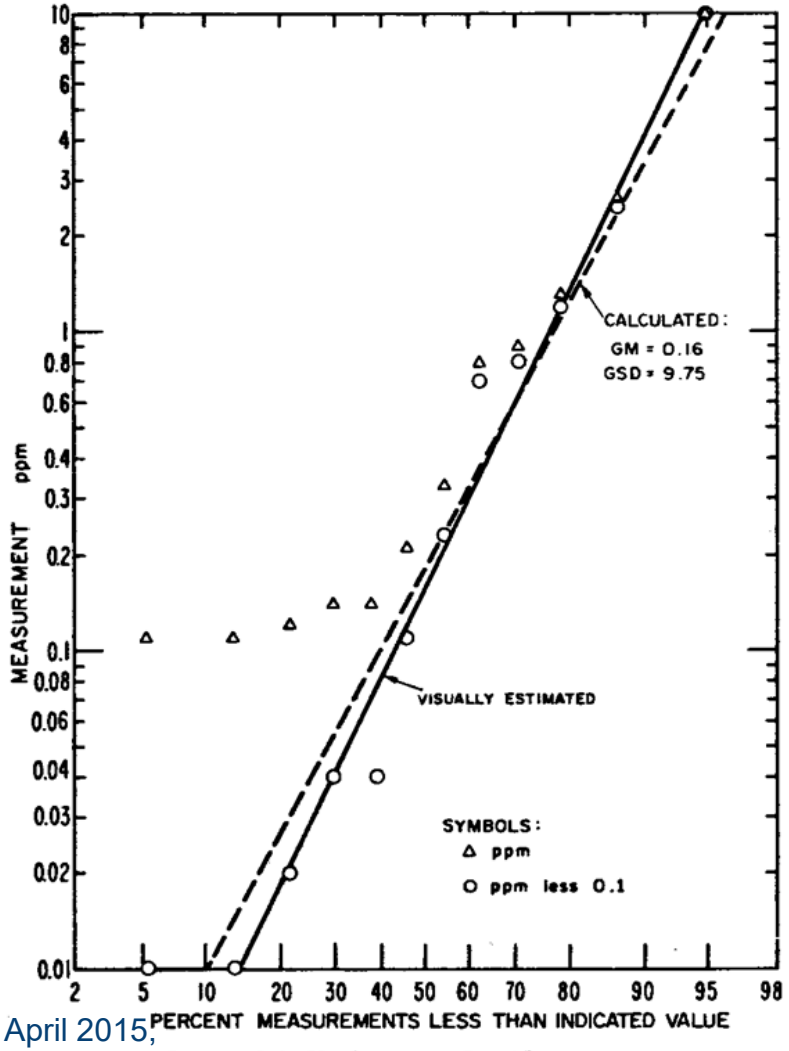


Figure I-4. Hydrogen fluoride measurement distribution.

Afternoon session

- Demo BW_Stat (Tom)
- Working with BW_Stat (you)
- Other tools (Jérôme)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