

Naar een correct, kosteneffectief en communicatief alternatief voor de EN689 (5.5.2) preliminary test

NVvA Symposium

05-04-2023, 11.30 – 12.00 uur

Theo Scheffers, Peter van Balen &
Robert Emonds

Conclusie 2022 Sessie T

- $C_{95,70\%}$ beoordeelt het blootstellings risico beter dan de preliminary test
- Voor blootgestelden en opdrachtgever
 - voor $N= 3, 4, 5$
- De uitleg van de statistische test in EN689 Annexen E-H is beroerd
- Communicatief inferieur t.o.v. Preliminary test

Three consecutive inhalable dust measurement OELV 5 mg/m³/8 hours

result (mg/m ³ /8hr)	% OELV	Preliminary test	GM	GSD	C _{95,70%}	Statistical test 5.5.3 Confidence C _{95%≤OELV}
0.76	15.2%					
1.52	30.4%					
0.81	16.2%	no decision	0.98	1.47	2.87	85.0% Compliance

5.5.2 Preliminary test a) 1)

Compliance if all results are below 0,1 OELV for a set of three exposure measurements

5.5.3 Statistical test

at least 70 % confidence that 95 % of the SEG distribution is at or below the OELV

NB: Meetonzekerheid is hier niet in meegenomen

4th consecutive inhalable dust measurement

OELV 5 mg/m³/8 hours

result (mg/m ³ /8hr)	% OELV	Preliminary test	GM	GSD	C _{95,70%}	Statistical test 5.5.3 Compliance if C _{X≥95,70%} =OELV X=
0.76	15.2%					
1.52	30.4%					
0.81	16.2%					
0.6	12%	no decision	0.87	1.49	2.29	92.5% compliance

5.5.2 Preliminary test a) 2)

Compliance if all results are below 0,15 OELV for a set of three exposure measurements

5.5.3 Statistical test

Less than 5 % of exposures in the SEG exceed the OELV with at least 70 % confidence

Example

5th consecutive inhalable dust measurements

OELV 5 mg/m³/8 hours

result (mg/m ³ /8hr)	% OELV	Preliminary test	(log)normal	GM	GSD	C _{95,70%}	Statistical test 5.5.3 Compliance if C _{X≥95,70%} =OELV X=
0.76	15.2%						
1.52	30.4%						
0.81	16.2%						
0.6	12%						
0.28	5.6%	no decision	logNormal	0.69	1.84	2.79	88.4% compliance

5.5.2 Preliminary test a) 3)

Compliance if all results are below 0,2 OELV for a set of three exposure measurements

5.5.3 Statistical test

Less than 5 % of exposures in the SEG exceed the OELV with at least 70 % confidence

6th consecutive inhalable dust measurements

OELV 5 mg/m³/8 hours

result (mg/m ³ /8hr)	% OELV	Preliminary test	(log)normal	GM	GSD	C _{95,70%}	Statistical test 5.5.3 Compliance if C _{X≥95,70%} =OELV X=
0.76	15.2%						
1.52	30.4%						
0.81	16.2%						
0.6	12%						
0.28	5.6%						
0.54	10.8%		lognormal	0.66	1.74	2.23	94.6% compliance

HYGINIST version 4.4.1 Comparing the exposure distribution with the OELV

File Statistics Lognormal frequency distribution Help

Start Raw data Limits Descriptive statistics Plot Compliance Mean UCL Compare 27

Descriptive statistics of the current data

Name C:\Users\ITS_com\Organisaties\verenigingen\WVVA\sympo

Sample size M= 6 samples of 8 hours

Degrees of Freedom df= 5

GM maximum likelihood= 0.6629 mg/m3

GSD= 1.7426

Statistical test: EN689 (2018) clause 5.5.3 & BOHS/NVvA (2011)

Occupational Exposure Limit Value OELV= 5 mg/m3

Confidence that less than 5% of the exposure distribution exceeds OELV = 94.6087 % **Compliance**

The 95%-tile upper tolerance limit with 70% confidence = 2.2331 mg/m3

The population fraction < OELV with 70% confidence = 99.7351 %

The test shall measure, with at least 70% confidence, whether less than 5% of the exposures in the SEG exceed the OELV (EN689-2018 clause 5.5.3_BOSH/NVvA 2011). Compliance decision (689 Annex F.3) is calculated with the non-central Student distribution using the algorithms of Owen (1968 p464-465).

Leide/EN689(1995) Wilks EN689(2018)/BOHS-NVvA(2011)

IH-Aligner

Versie: 9.3.2
PBC1

Raw data
Compliance testing EN689
IHSTATS_EN689
BWStat V3
IHSTATS_Bayes
Hyginist
IHDA
Expostats Tool1
Expostats Tool2



BELGIAN SOCIETY FOR OCCUPATIONAL HYGIENE

BWStat version 3.0.2.

IHSTAT-Bayes



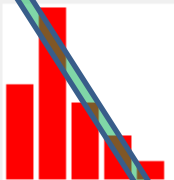
HEALTHIER WORKPLACES | A HEALTHIER WORLD



EXPOSTATS

BAYESIAN CALCULATOR

STATISTICAL TOOLS FOR THE INTERPRETATION OF INDUSTRIAL HYGIENE DATA



IHDataAnalyst - AIHA 2022
Version 2022.01



HYGINIST

HYGINIST version 4.4.1

for Windows 10

Copyright 1992-2020
Theo Scheffers Arbo Consultancy TSAC theo.scheffers@tsac.nl

Login

HYGINIST User information

System user

Your name

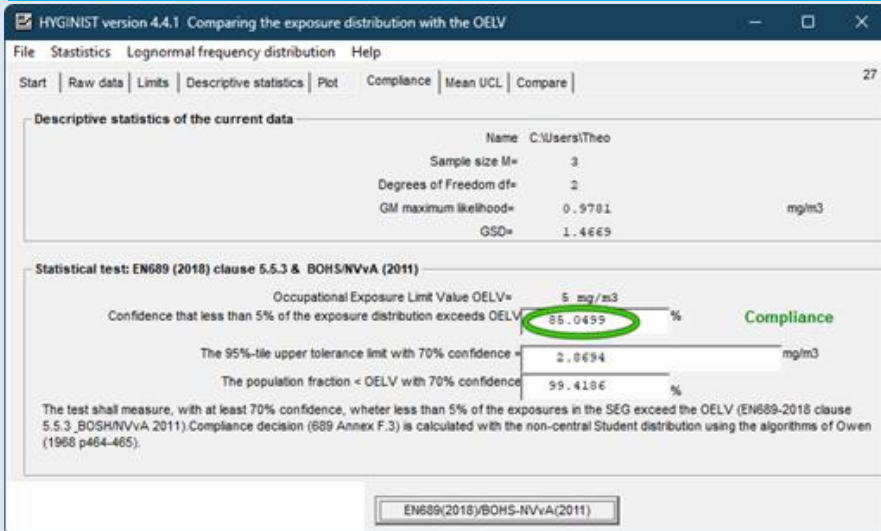
Password

Programmer Password

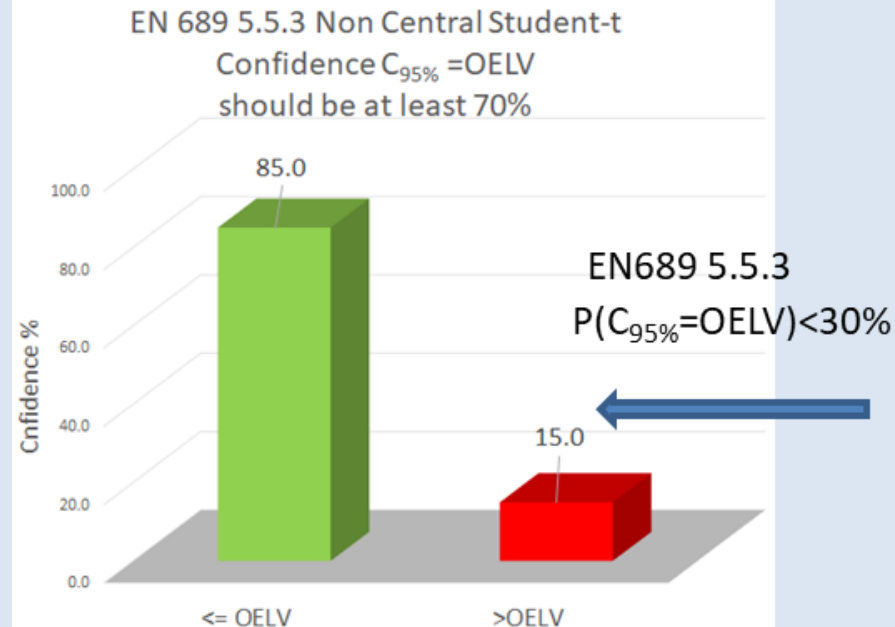
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IH-Aligner Versie: 9.3 PBC1

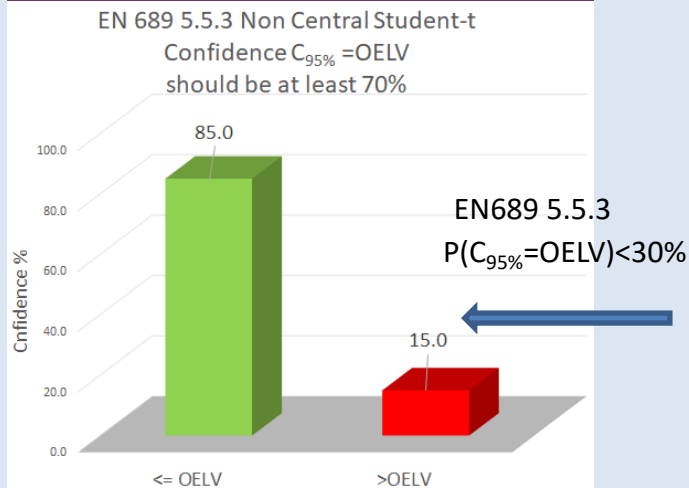


Inhalable dust OELV 5 mg/m³/8 hours

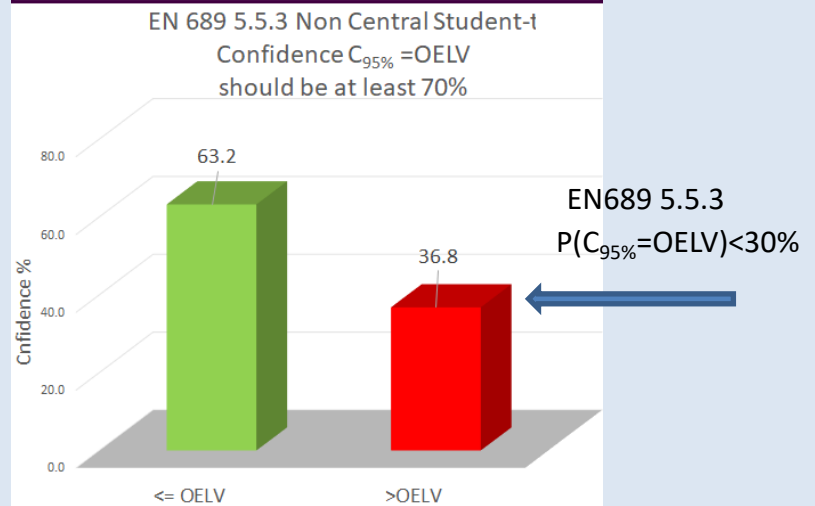


$C_{95\%}$ confidence for inhalable dust OELV = 1.25, 2.5, 5 & 20 mg/m³/8 hours

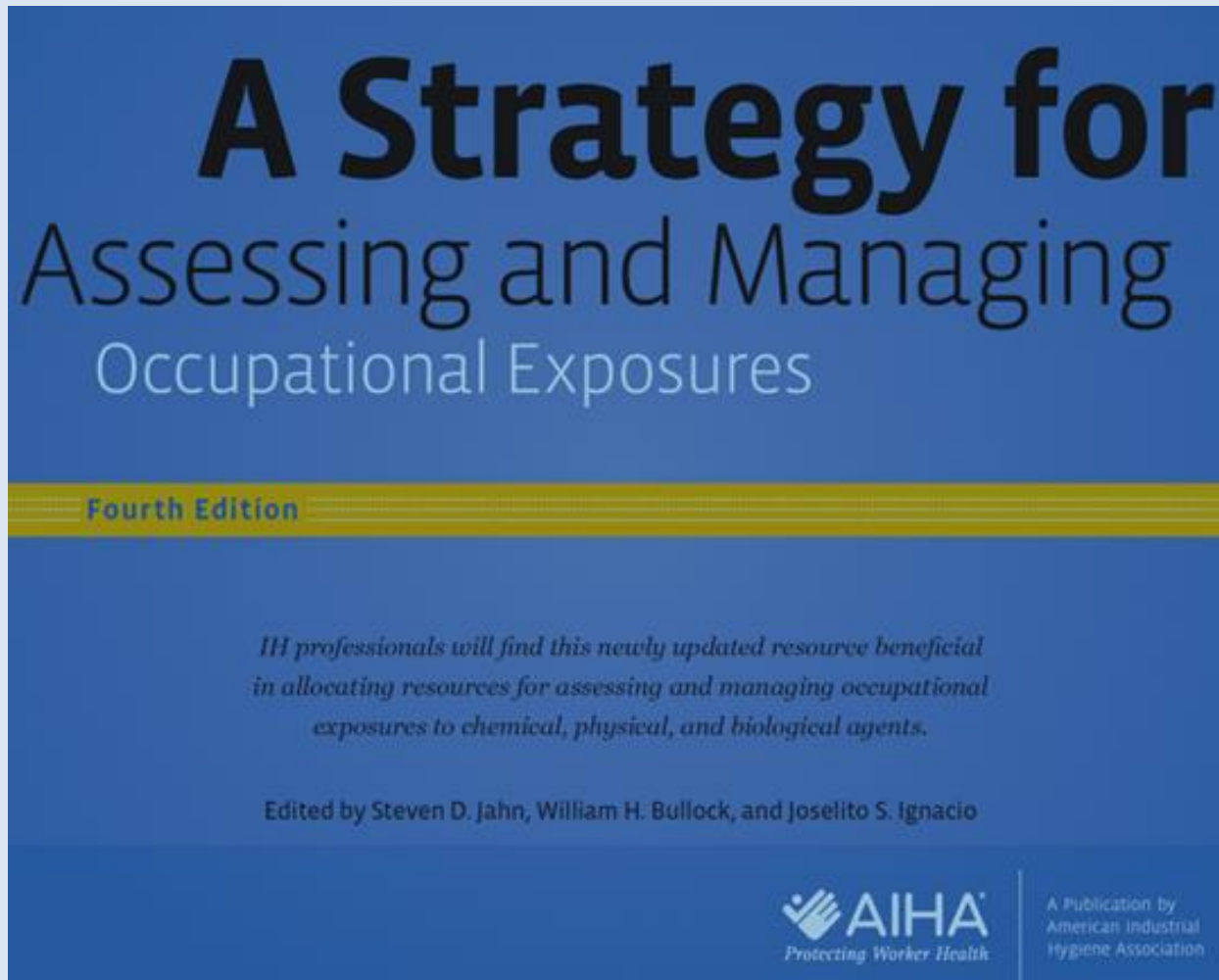
Inhalable dust OELV 5 mg/m³/8 hours



Inhalable dust OELV 2.5 mg/m³/8 hours



AIHA Exposure categories



AIHA Exposure categories

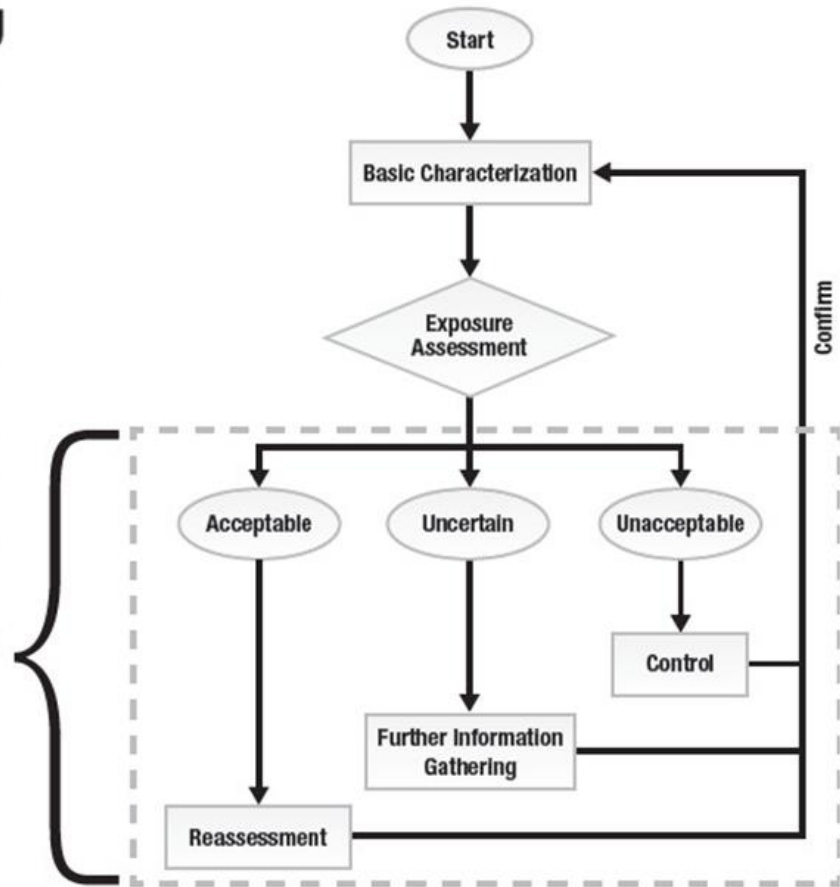
A Strategy for Assessing and Managing Occupational Exposures



Steven D. Jahn, CIH, MBA
 William H. Bullock, DHSc, CIH, CSP
 Joselito S. Ignacio, CIH, CSP, MPH, REHS/RS

Management and Exposure Control Categories	
SEG Exposure Control Category**	Applicable Management/ Controls
0 (<1% of OEL)	no action
1 (<10% of OEL)	procedures and training, general hazard communication
2 (10-50% of OEL)	+ chemical specific hazard communication, periodic exposure monitoring
3 (50-100% of OEL)	+ required exposure monitoring, workplace inspections to verify work practice controls, medical surveillance, biological monitoring
4+ (>100% of OEL, Multiples of OEL; e.g., based on respirator APFs)	+ implement hierarchy of controls, monitoring to validate respirator protection factor selection

**Upper Tail Statistic decision = 90th, 95th, 99th percentile



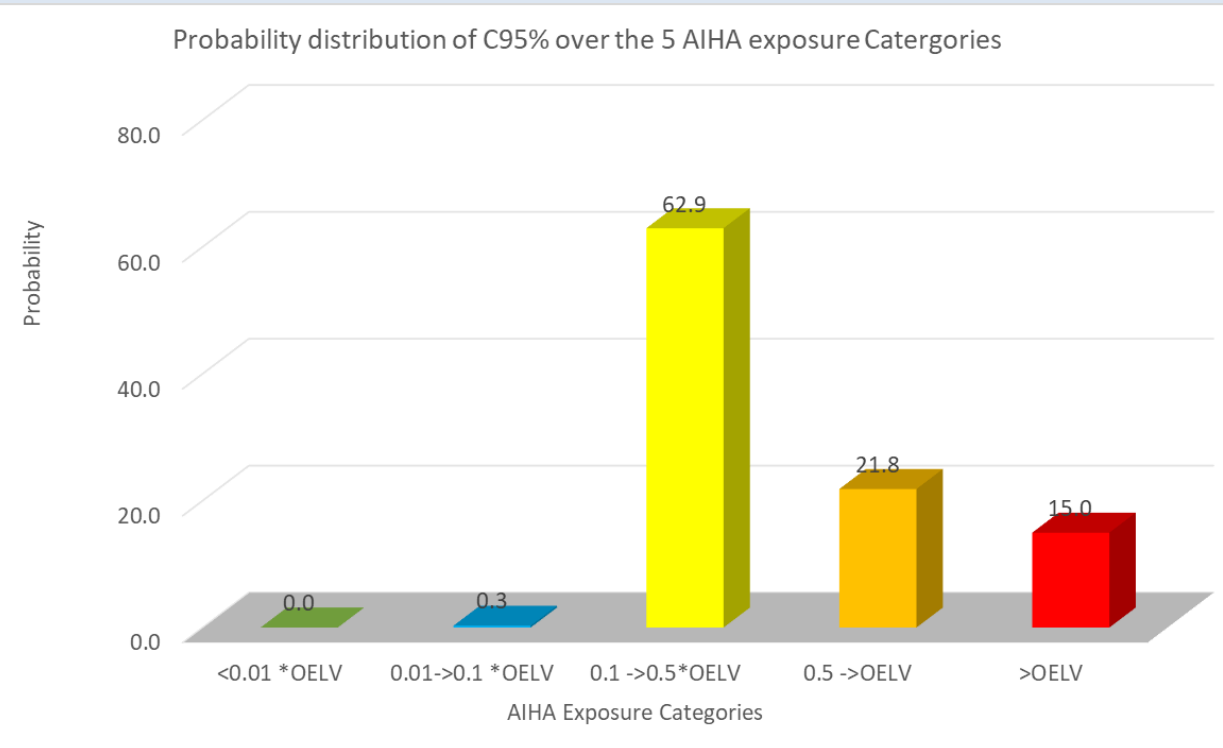
Chapter 1: Introduction2

By John Mulhausen and Joseph Damiano

AIHA (NIOSH 1977 p118) objective: *“Employer should try to attain 95% confidence that no more than 5% of employee days are over the standard”*

AIHA Exposure categories

result (mg/m ³ /8hr)	% OELV	Preliminary test	GM	GSD	C _{95,70%}	Statistical test 5.5.3 Confidence C _{95%} ≤ OELV
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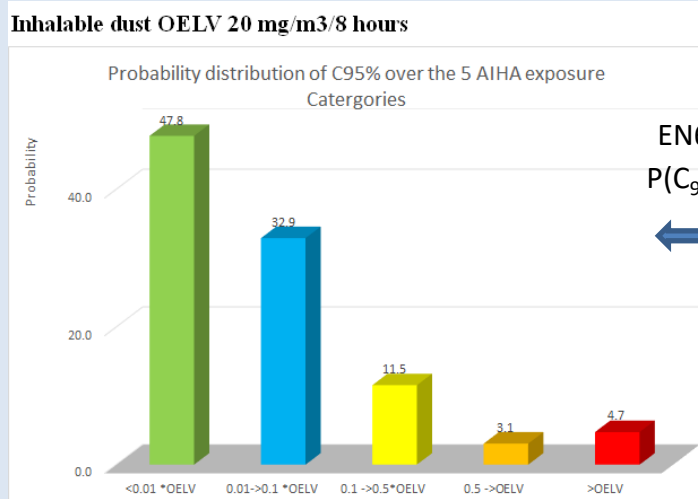
Management and Exposure Control Categories	
SEG Exposure Control Category**	Applicable Management/ Controls
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IH-Aligner Version: 9.3 PBC1

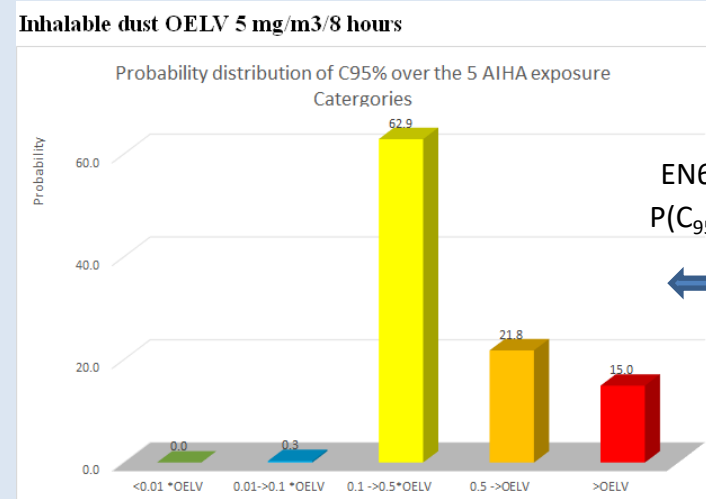
<https://real-statistics.com/students-t-distribution/noncentral-t-distribution/>

REAL STATISTICS USING EXCEL

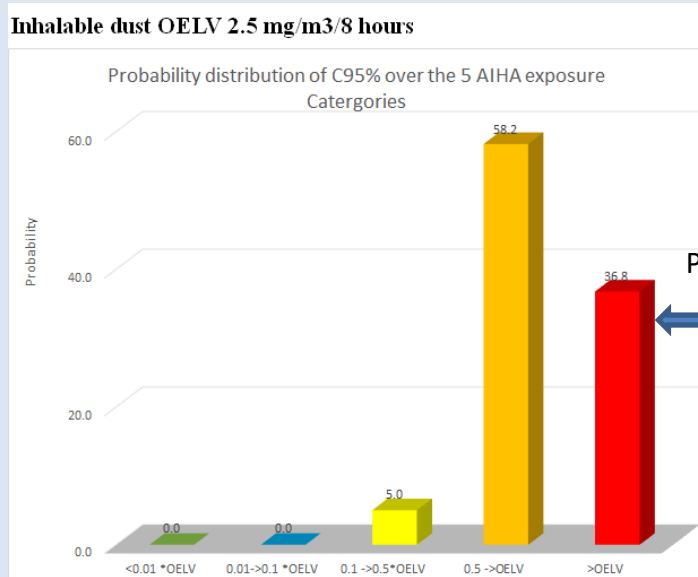
AIHA Exposure categories inhalable dust for OELV 1, 2, 5 & 20 mg/m³/8 hours



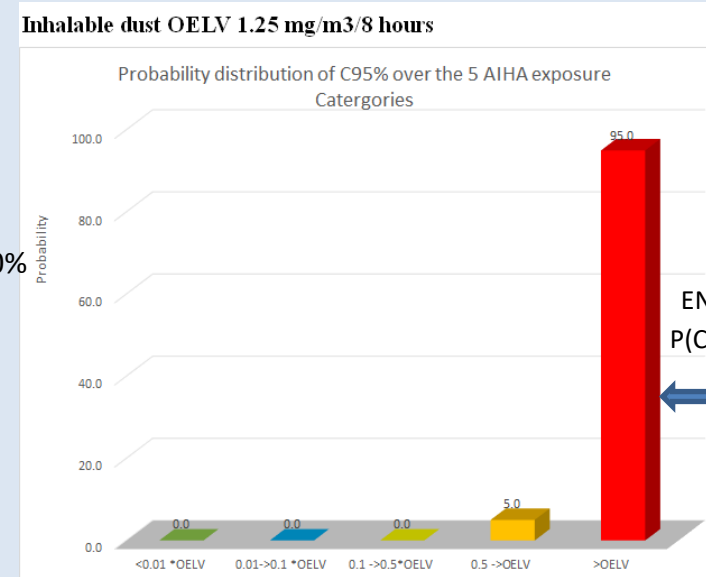
EN689 5.5.3
 $P(C_{95\%} = \text{OELV}) < 30\%$



EN689 5.5.3
 $P(C_{95\%} = \text{OELV}) < 30\%$



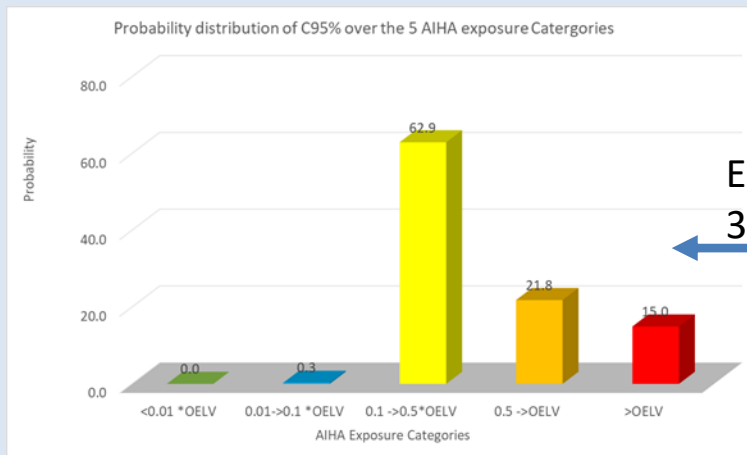
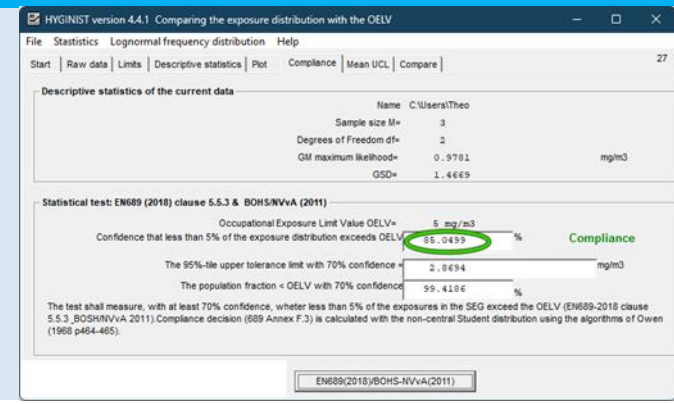
EN689 5.5.3
 $P(C_{95\%} = \text{OELV}) < 30\%$



EN689 5.5.3
 $P(C_{95\%} = \text{OELV}) < 30\%$

Numerical method & applications (1)

- IH-Aligner using
 - HYGINIST or
 - ‘RealStatistics’ Excel addin

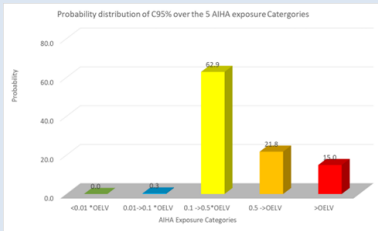


<https://real-statistics.com/students-t-distribution/noncentral-t-distribution/>

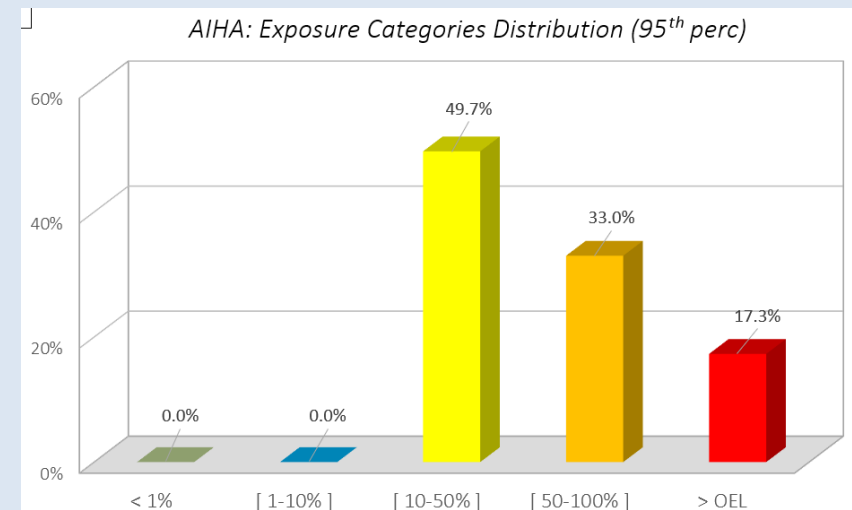
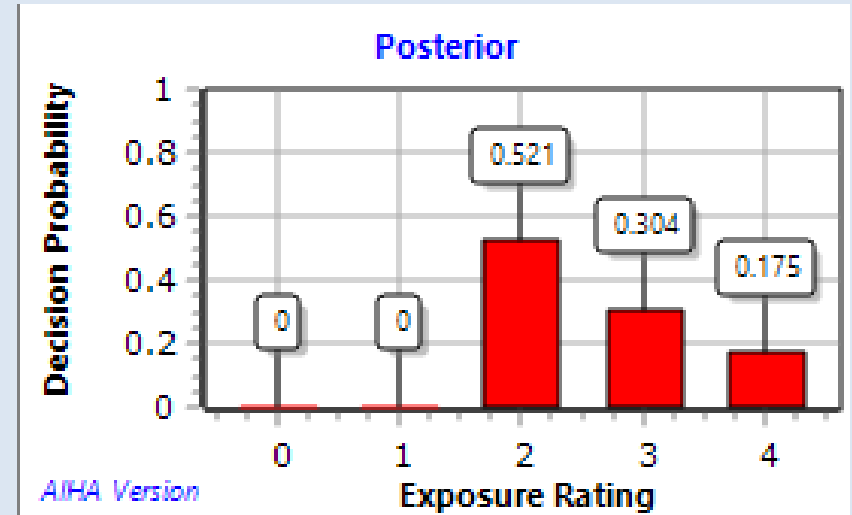
REAL STATISTICS USING EXCEL

$$\text{Confidence} = \text{NT_DIST}((\ln(\text{F.OELV}) - \ln(\text{GM}) / \ln(\text{GSD})) * \text{SQRT}(N); N-1; \text{SQRT}(N) * \text{NORM.S.INV}(0.95))$$

Bayesian/Monte-Carlo applications (2)



- IHDA-AIHA
- Outcome depend on prior settings
- IHStat_Bayes NL version!
- Varying Outcome (MonteCarlo)



AIHA exposure categories

Advantages

- Professional looks/
impressive

Disadvantages

- 5 cat# is not EN689 and overdone
- No formal compliance level
- Complex within Excel
- Complex installation IHStat

Does this improve risk communication with stakeholders?

EN689: two & three categories

5.1.5 basic characterization

$C_{95\%} \ll \text{OELV}$	No sampling
$C_{95\%} \gg \text{OELV}$	No sampling
$C_{95\%} \approx \text{OELV}$ No decision=>	Sampling plan

5.5.2 preliminary test N=3, 4 & 5 samples

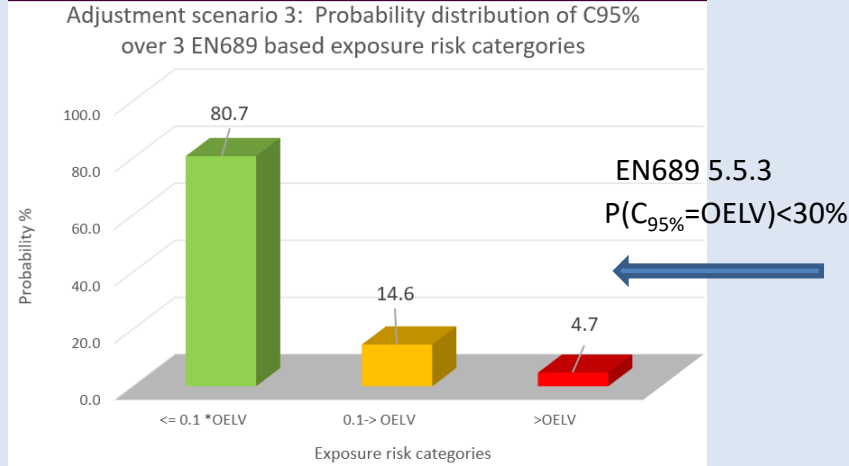
$C_{\max} \leq \text{fr}(\text{OELV})$	Compliance
$C_{\max} > \text{OELV}$	Non-compliance
$\text{fr}(\text{OELV}) < C_{\max} \leq \text{OELV}$	No decision=>more measurements

5.5.3 statistical test N≥2 samples

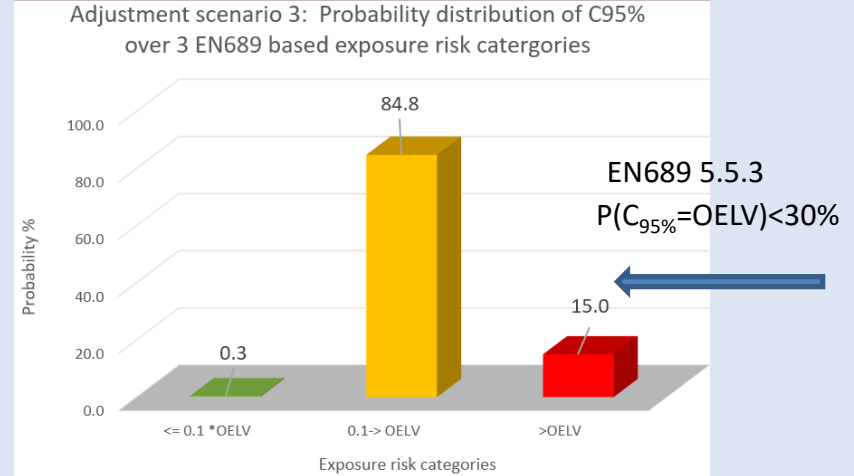
$C_{95,70\%} \leq \text{OELV}$	Compliance
$C_{95,70\%} > \text{OELV}$	No decision=>more measurements or Exceedance

EN689 exposure categories inhalable dust for OELV 1, 2, 5 & 20 mg/m³/8 hours

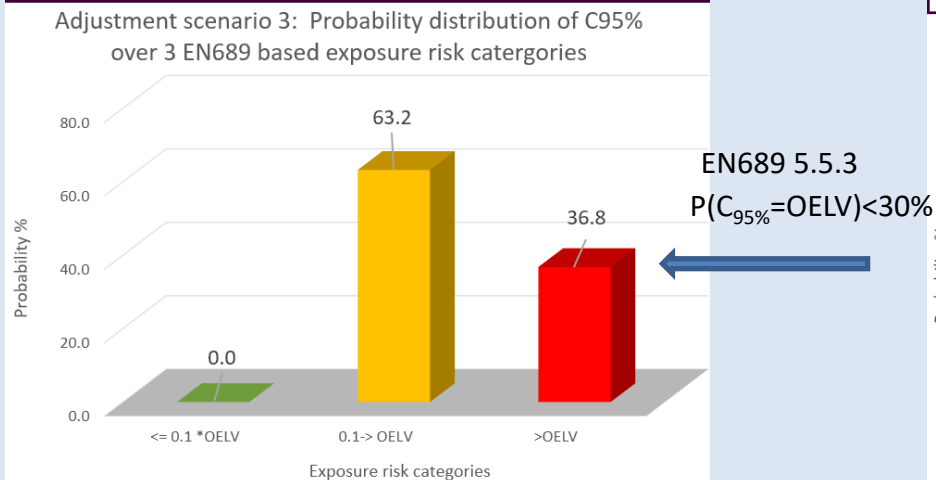
3 metingen inhaleerbaar stof OELV=20 mg/m³



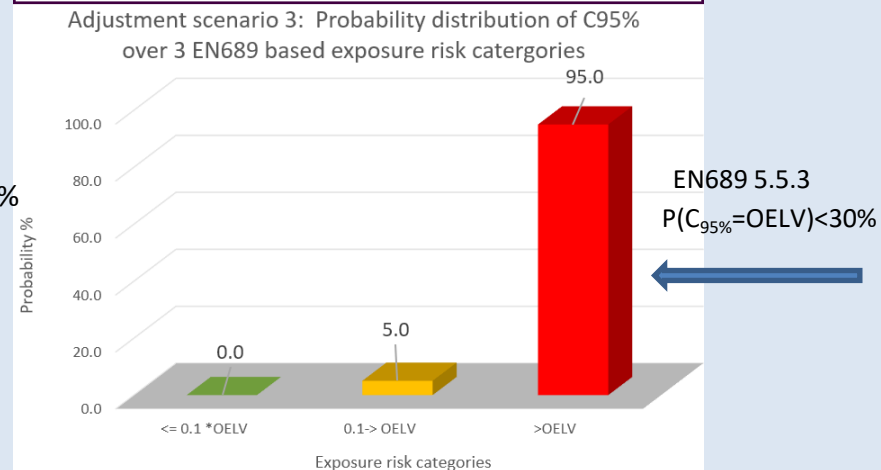
3 metingen inhaleerbaar stof OELV=5 mg/m³



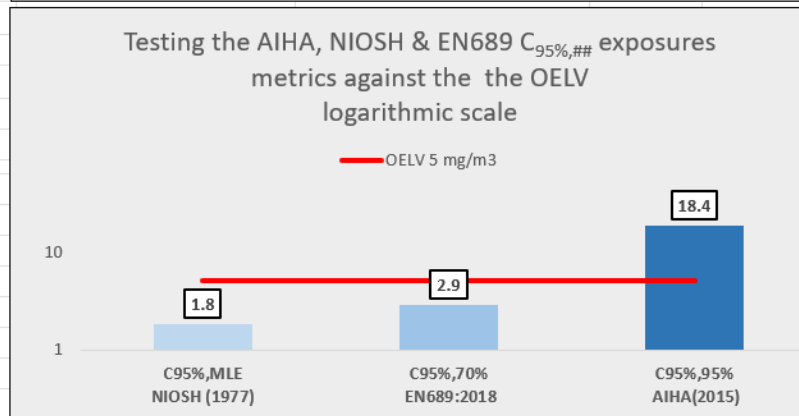
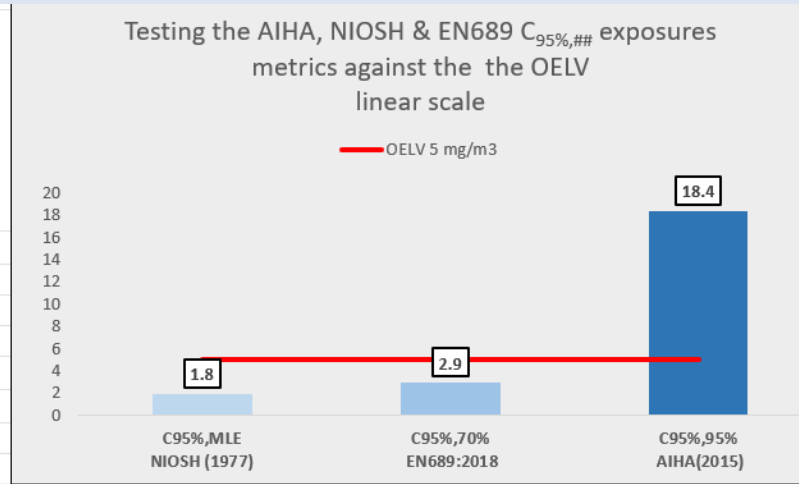
3 metingen inhaleerbaar stof OELV=2.5 mg/m³



3 metingen inhaleerbaar stof OELV=1.25 mg/m³



EN689 & AIHA IHStat combined



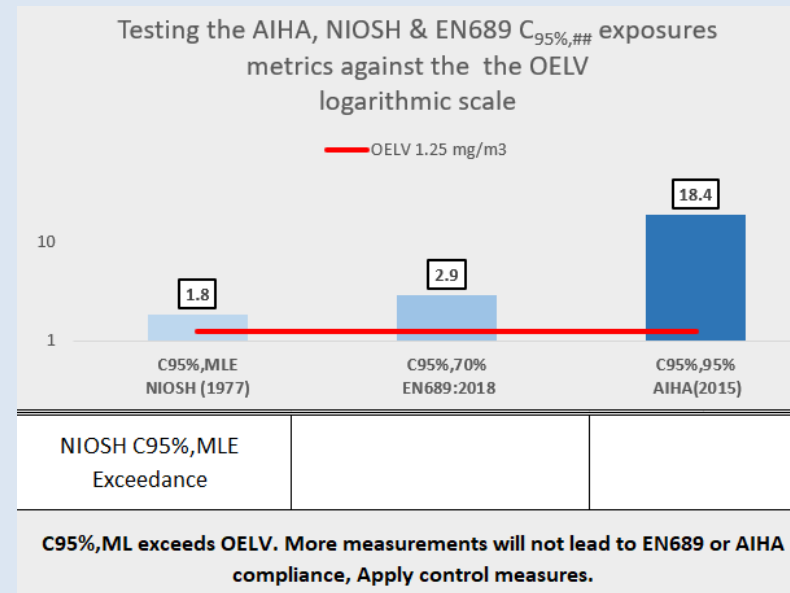
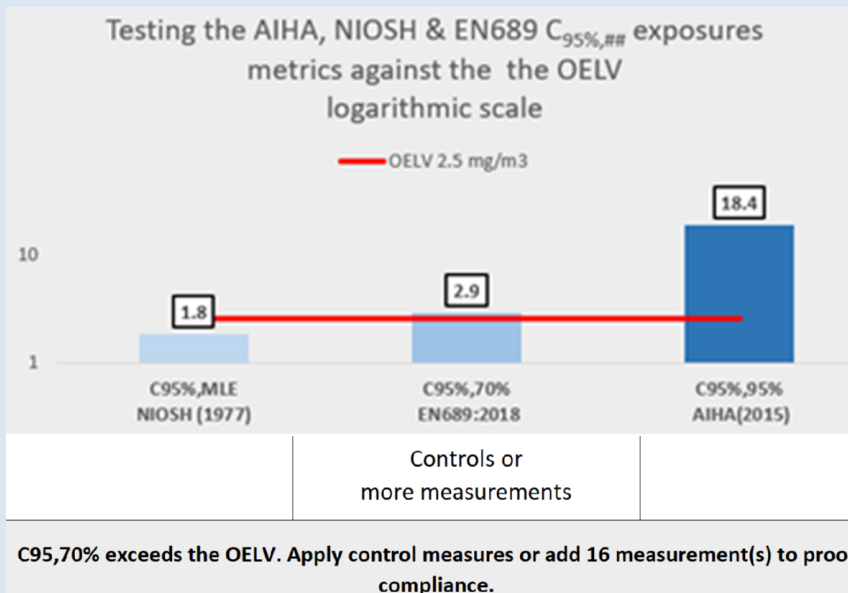
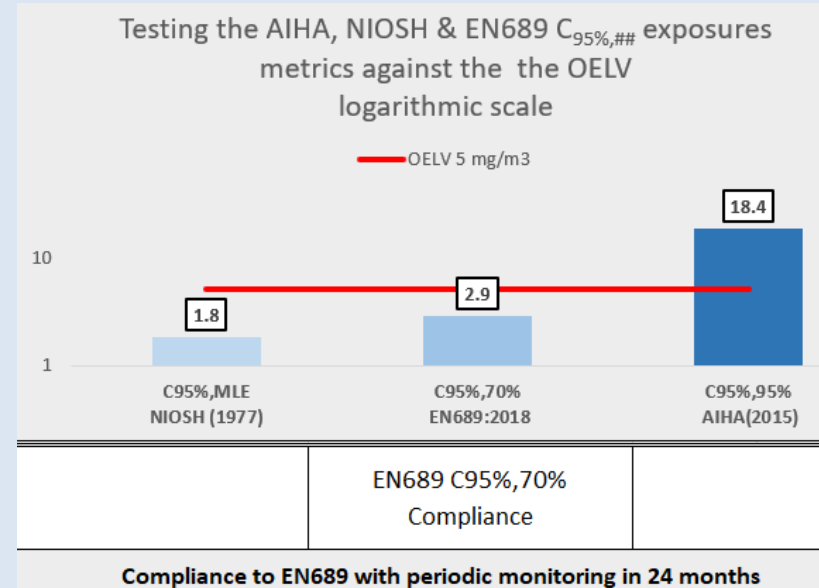
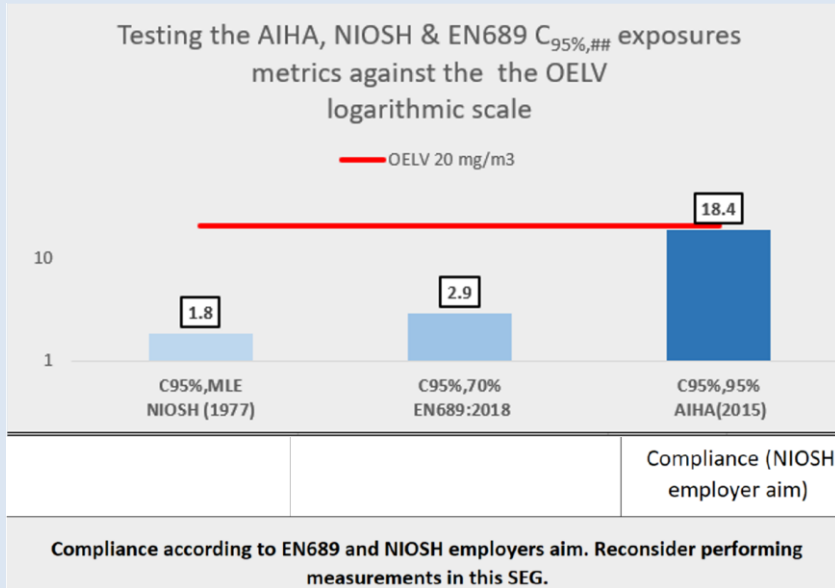
Decision		EN689 C95%,70% Compliance	
Preference is log-normal distribution	Compliance to EN689 with periodic monitoring in 24 months		

IH-Aligner Versie: 9.3 PBC1



AIHA (NIOSH 1977 p118) objective:
“Employer should try to attain 95% confidence that no more than 5% of employee days are over the standard”

Vier uitkomsten



EN689 & AIHA/IHStat combined

Advantages vs AIHA

- In IH-Aligner
- Makes decision
- Combines EU & US
- Normal/Lognormal
- Periodic monitoring
- No 'RealStatistics'
- No Monte-Carlo & Bayesian priors
- SER feasibility

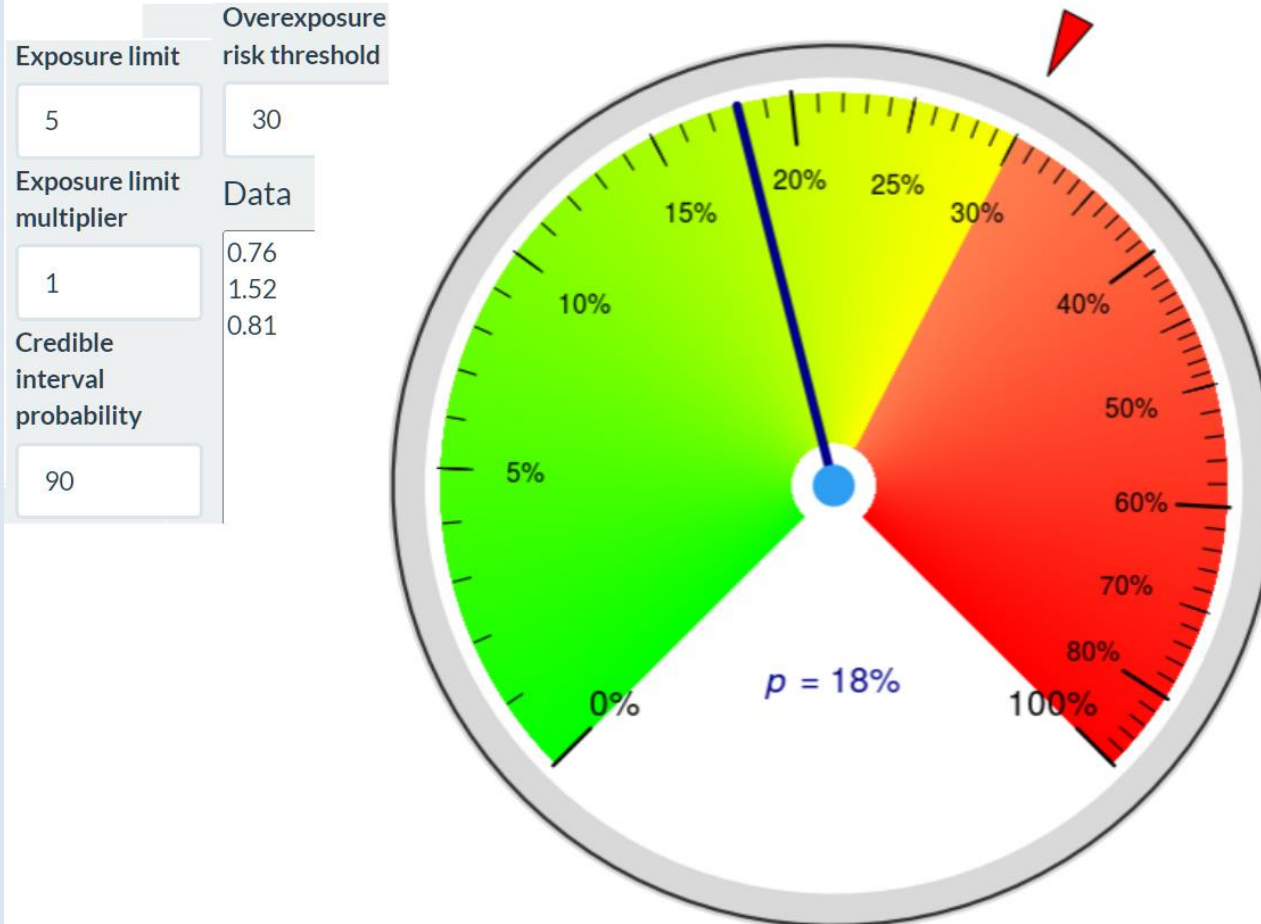
Disadvantages

- Less impressive?

Expostats

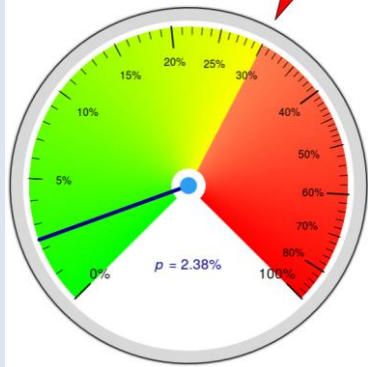
<https://lavoue.shinyapps.io/Tool1v3En/>

Tool1: Data interpretation for one similarly exposed group

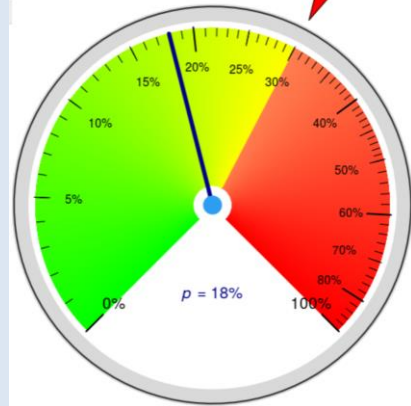


EN689 vs Expostats $C_{95\%}$ confidence

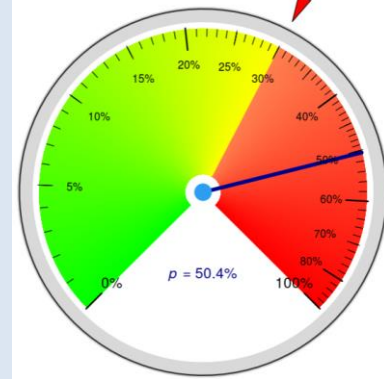
3 metingen inhaleerbaar stof
OELV=20 mg/m³



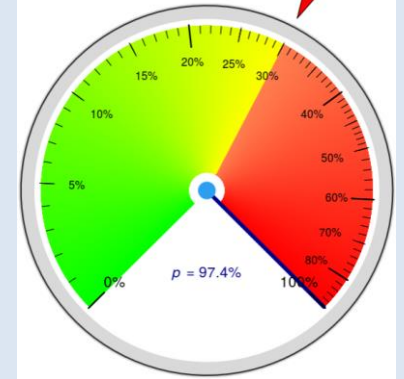
3 metingen inhaleerbaar stof OELV=5 mg/m³



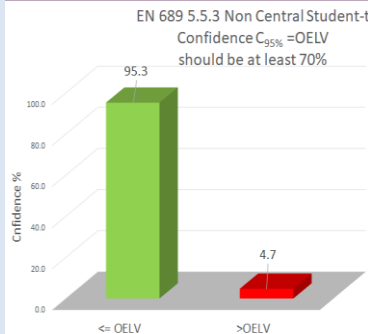
3 metingen inhaleerbaar stof
OELV=2.5 mg/m³



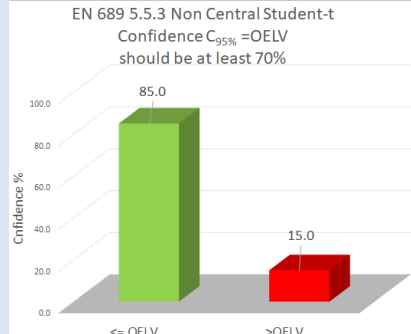
3 metingen inhaleerbaar stof
OELV=1.25 mg/m³



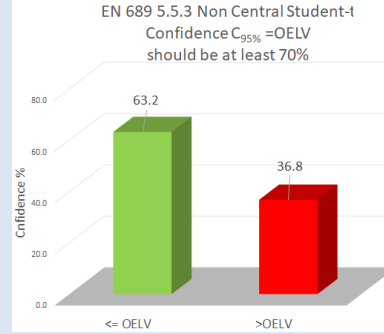
Inhalable dust OELV 20 mg/m³/8 hours



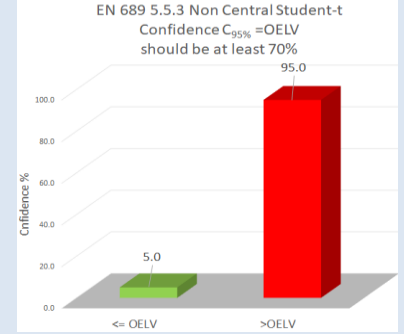
Inhalable dust OELV 5 mg/m³/8 hours



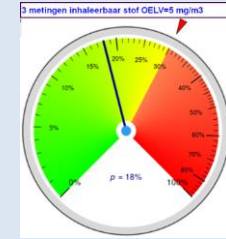
Inhalable dust OELV 2.5 mg/m³/8 hours



Inhalable dust OELV 1.25 mg/m³/8 hours



Expostats Tool1



Advantages

- Dichotome (like EN689)
- Online
- Easy (if you know what to do)
- Speedometer looks nice

Disadvantage

- Ingrainged Bayes proir may misfit your SEG

May improve risk communication with stakeholders

Boodschap 1

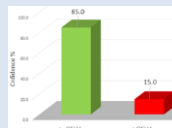
NVvA leden, arbeidshygiënisten en andere blootstellingsbeoordelaars laten bij N=3,4,5 naast elkaar zien wat de uitkomst is van de preliminary test en de statistische test

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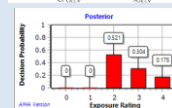
Boodschap

Er zijn voldoende eenvoudige en visuele Apps voor de EN689 statistische test (online, Excel, .exe) vanaf 2 metingen

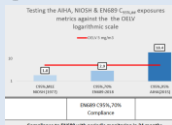
- Sound science
- Bruikbaar vanaf $N \geq 3$



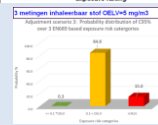
- AIHA: 5 categorieën = te veel



- 1^e voorkeur:



- 2^e voorkeur:



beide in IH-Aligner

- Internationaal uitdragen via EPOH

IH-Aligner

Versie: 9.3.2
PBC1