Asociación Española
de Higiene Industrial

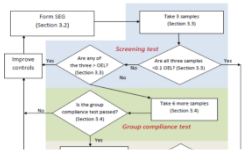
Revisión de la Norma EN 689:1995 y la aplicación informática BWStat

La Asociación Española de Higiene Industrial

16 de octubre, 2015

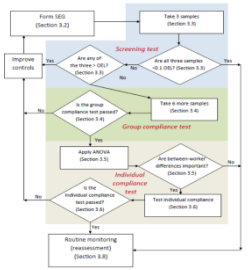
Horario: 09.30 – 13.00 y 14.00-17.00

Agenda



When	What	Who
09:30 – 10:00	Welcome and introduction	Rudolf
10:15 – 11:00	Industrial Hygiene and EN 689 Basic characterization 5.1 Similar Exposure group (SEG) 5.2.1	Theo
11:00 – 11:15	Break	
11:15 – 12:00	Validity measurement 5.4.1 (outliers, LoQ) and the SEG 5.4.2 + Annex E & XX	Theo
12:00 – 13:00	Testing compliance 5.5 & Undetectables Differences with the current 689	Theo
13:00 – 14:00	Lunch	
14:00 – 15:00	Introduction to BW Stat v2	Tom
15:00 – 15:15	Break	
15:15 – 16:30	BW Stat v2 exercise	Tom
16:30 – 17:00	Feedback and evaluation	Rudolf

Aim of Industrial Hygiene: Keep exposure in control!



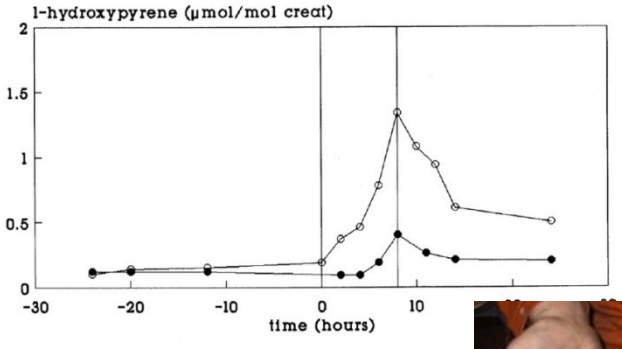
- Workers health & workplace hygiene
- Law (penalty)
- Installation integrity
- Insurance rates
- Liability claim
- Reputation management

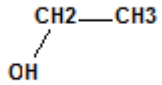
EU Directive (98/24): Employer, keep the occupational exposure to chemicals in control, every day and on every workplace

Today

Not in the workshop:

- Biological Monitoring
- Skin permeation
- Mixtures
- Deriving OELVs
- Models
- Un[illegible]k sch[illegible]

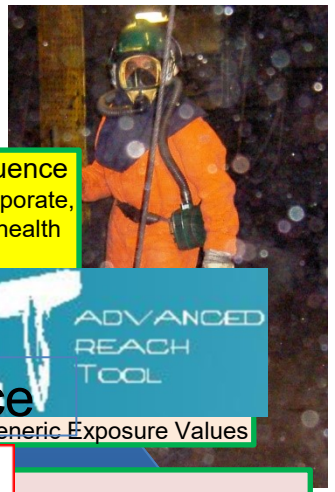


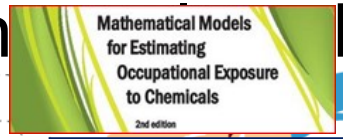


Health based only
SCOEL, DECOS, DFG, ACGIH-TLV (>1996)

Legal **compliance** limits with technical and/or economical feasibility:
- EU BLV
- ES DLEP
- UK WEL
- Ge TRGS900
- OSHA PEL

Health based, with stakeholder influence
AGS, NIOSH REL (<2013), EU IOLV, Corporate, ECETOC, ORAS/WEEL , older (<1996) health based





Stoffen

ADVANCED REACH TOOL

mixie

$$\sum_{i=1}^{i=n} \left(\frac{C_i}{OELV_i}\right) \leq 1$$

Lead substance

Banding concentration ranges, Generic Exposure Values

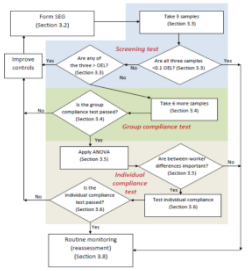
XLUNIFAC

DPD+

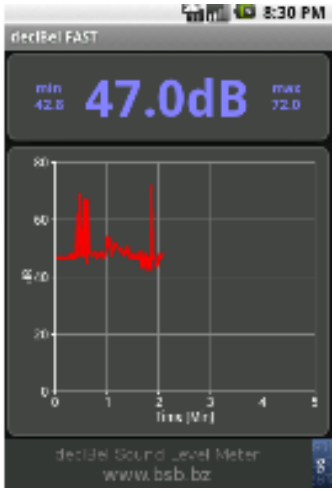
e endpoint MTD [illegible] TTC, read across, expert judgment (Nano)

Focus:TWA_{8hrs} compliance with OELV, without PPE

Ideally: control in space, time & population



- Possible for ionising radiation, noise, ozon
- Difficult for most other occupational loads including chemical exposure
  - sampling limitations
  - analytical limitations
  - costs



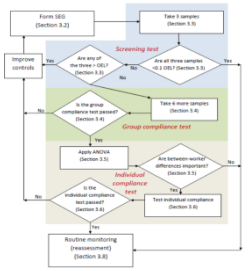
Revisión de la norma EN689, 16/10/2015

Asociación Española de Higiene Industrial

BOHS The Chartered Society for Worker Health Protection

Nederlandse Vereniging voor Arbeidshygiëne

A rather empty space-time universe



Occupational contact with chemicals:

- X billion workers exposed
- >40 year working life
- Up to 250 shifts a year
- Up to 8-12 hours a day
- 110.000 Notified substances in Europe

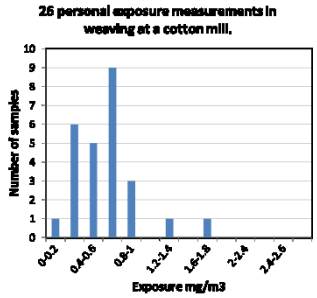
Exposure databases: >1.000.000 results

We know just a little bit about exposure!

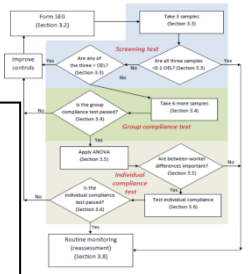
But we need to say something with confidence

Even more complex: Exposure variability

- Today : $TWA_{8\ hours}$=1 ppm
- What will it be tomorrow? 1, 0.1 or 10?
- A group of workers doing the same: Are their $TWA_{8\ hours}$ equal? little different? much different?
- And on the average throughout say one year?



The EU solution: EN 689 & BW_Stat!



CEN/TC 137

Date: 2015-06

prEN 689:2015

CEN/TC 137

Secretariat: DIN

Workplace exposure — Measurement of exposure by inhalation to chemical agents — Strategy for testing compliance with occupational exposure limit values

Testing Compliance with Occupational Exposure Limits for Airborne Substances

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

September 2011

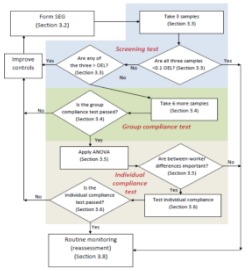
Nederlandse Vereniging voor Arbeidshygiëne
Postbus 1762,
5602 BT Eindhoven
The Netherlands
www.arbeidshygiene.nl/

A sampling strategy using:

- a limited number of measurements
- carried out in conditions representative of normal activities
- of a similarly exposed group (SEG) of workers

and a statistical test to decide whether exposures in the SEG comply with the limit value.

EN 689 working document N029 (June 2015)



CEN/TC 137

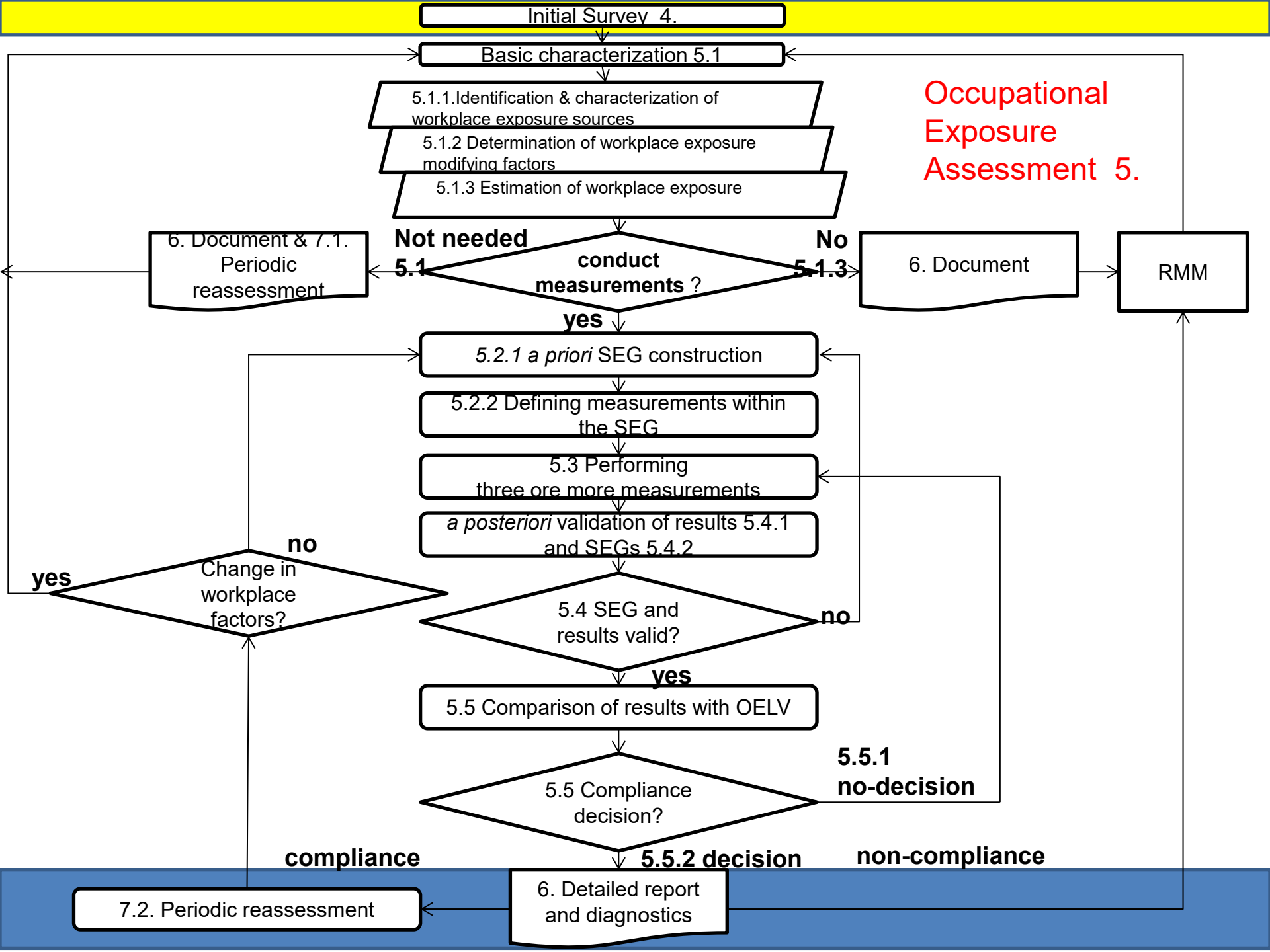
Date: 2015-06

prEN 689:2015

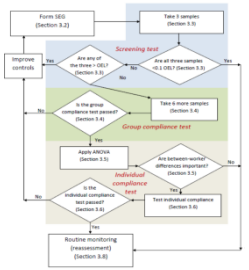
CEN/TC 137

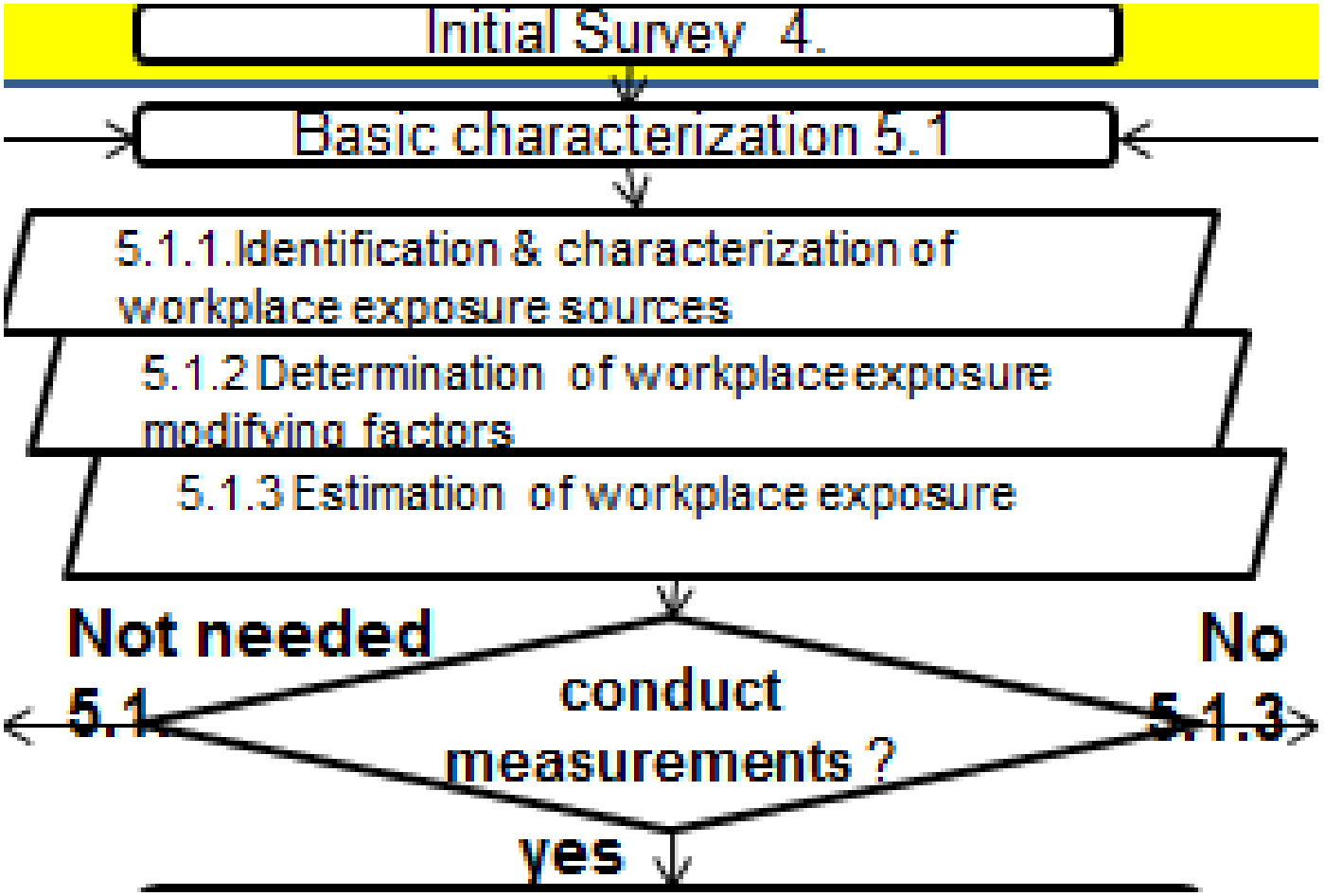
Secretariat: DIN

Workplace exposure — Measurement of exposure by inhalation to chemical agents — Strategy for testing compliance with occupational exposure limit values

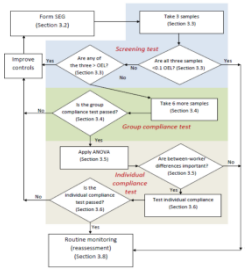

Initial Survey 4.
Basic characterization 5.1
5.1.1.Identification & characterization of workplace exposure sources
5.1.2 Determination of workplace exposure modifying factors
5.1.3 Estimation of workplace exposure
Occupational Exposure Assessment 5.
Not needed
5.1
conduct measurements ?
No
5.1.3
6. Document & 7.1. Periodic reassessment
6. Document
RMM
yes
5.2.1 a priori SEG construction
5.2.2 Defining measurements within the SEG
5.3 Performing three ore more measurements
a posteriori validation of results 5.4.1 and SEGs 5.4.2
no
yes
Change in workplace factors?
5.4 SEG and results valid?
no
yes
5.5 Comparison of results with OELV
5.5.1
no-decision
5.5 Compliance decision?
compliance
5.5.2 decision
non-compliance
7.2. Periodic reassessment
6. Detailed report and diagnostics

EN 689 (2015) first steps



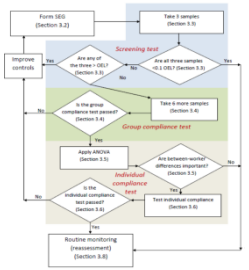


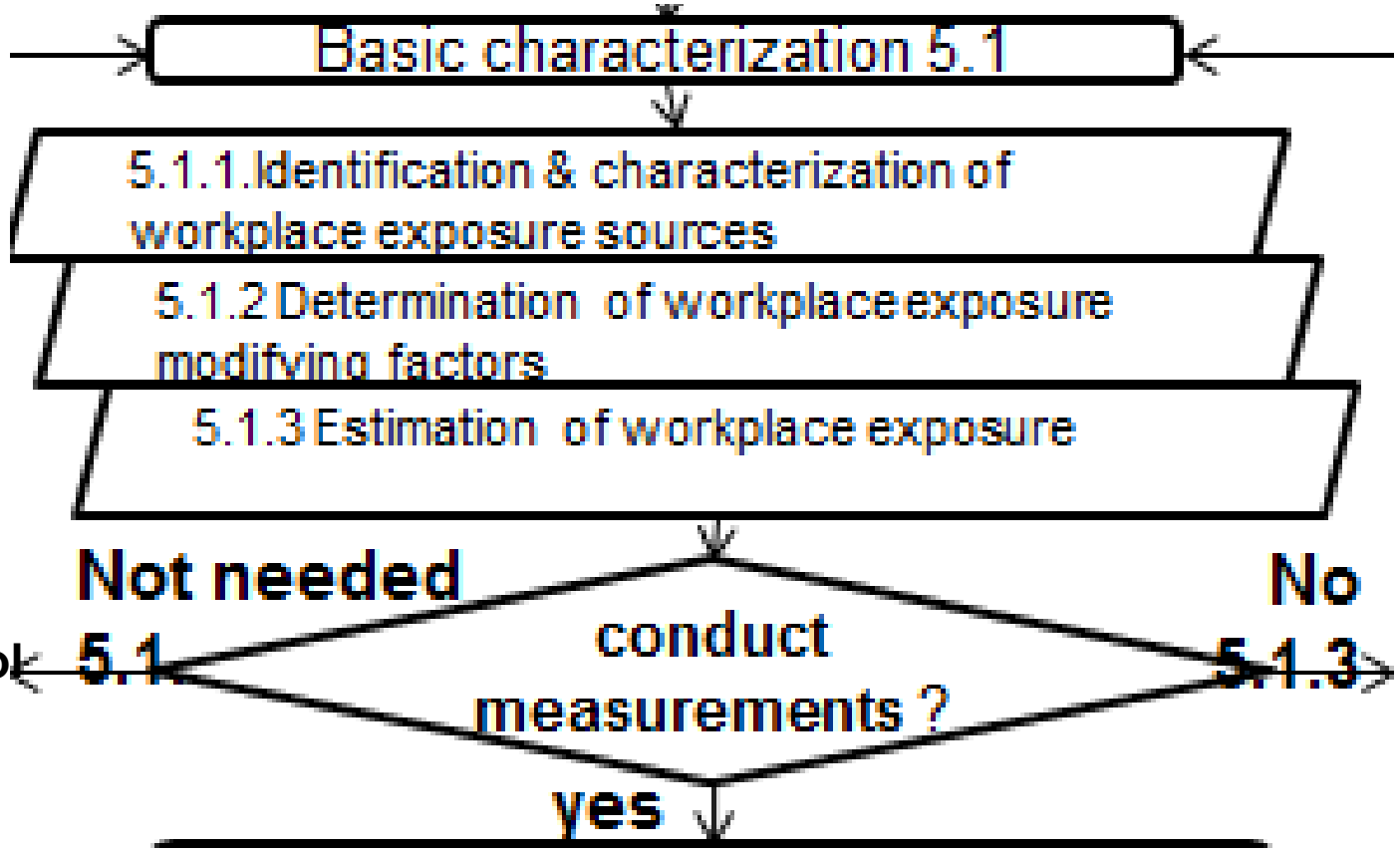
Initial Survey: Stakeholder question



- *Stakeholders like employer, employee, government, insurance or any others may demand a skilled appraiser to perform an chemical exposure assessment or to advice if such an exposure assessment is needed.*
- *The appraiser performs an initial survey based on his/her professional judgement and if possible on a visit of the workplace.*
- *The appraise shall motivate, report and communicate his decision to the stakeholders.*

EN 689 (2015) second step

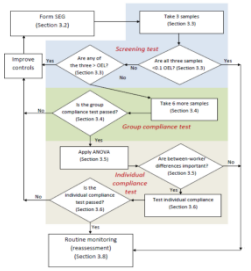




In Control

Immediate Controls

5.1.1 Identification of chemical agents

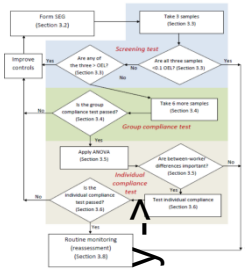


- Products, mixtures, by-products -> CAS#/EC#
- Physical Chemical properties
  - Qualitative: molecular dispersion (ppm) or conglomerates (mg/m^3)
  - Quantitative: Saturation concentration (C_{sat}) or dustiness
- Health hazard properties (GHS/CLP)
- Risk potential assessment tools like Control Bar
- See e.g. http://www.tsac.nl/websites.html

5.1.1 & Annex B: OELV

Legal **compliance** limits with technical and/or economical feasibility:

- EU BLV
- ES DLEP
- UK WEL
- Ge TRGS900
- OSHA PEL



Epidemiology ->

Health based only
SCOEL, DECOS, DFG, ACGIH-TLV (>1996)

Health based, with stakeholder influence
AGS, NIOSH REL (<2013), EU IOLV, Corporate, ECETOC, ORAS/WEEL , older (<1996) health based

Default factor. Prescriptive, process based
DNEL, Dutch Health Council Gr2000-15/OSH

Hazard Banding
Kick-off levels, Control Banding concentration ranges, Generic Exposure Values

Generic
single endpoint MTD & RD50, QSAR, structural activity TTC, read across, expert judgment (Nano)

Data rich ->

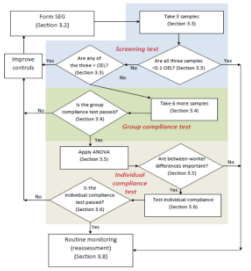
<-Data poor

Asociación Española de Higiene Industrial

BOHS The Chartered Society for Worker Health Protection

Nederlandse Vereniging voor Arbeidshygiëne

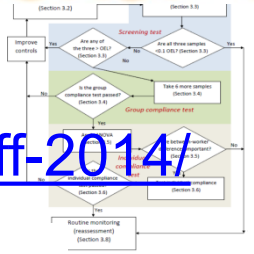
Substances with exposure & no OELV



- DOHSBase ES:
  - 170.000 chemicals
  - ~6000 substances with ≥ 1 OELV or DNEL
- REACH DNEL exempted:
  - Registration exempted <1 t/year
  - CSA exempted 1-10 ton/year (> 10000)
  - intermediates, polymers, exemptions (natural, non dangerous) etc.
- CLP ~110.000 substances EU notified as dangerous, no DNEL/OELV
  - Kick-off levels
  - Control banding

Kickoff Levels

https://www.dohsbase.nl/es/content-2-2-2/valores-kick-off-2014/



Dust/Aerosol

Proposed kick-off values for dust/aerosols
(basis: COSHH Essentials)

Hazard Group	4	3	2 *	1
H-statements	H334, H340, H341, H350, H350i	H300, H310, H330, H351, H360F/D/FD/Fd /Df, H361f/d/fd, H362, H372	H301, H302, H311, H312, H314, H317, H318, H331, H332, H335, H370, H371, H373, EUH071	H303, H304, H305, H313, H315, H316, H319, H320, H333, H336, EUH066, other H-statements n.o.s., REACH Annex IV
Dusts (mg/m³)	**0,0001**	**0,01**	**0,1**	**1**

*: COSHH Essential Groups B+C combined

Vapor/Gas

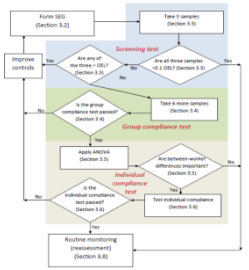
Proposed based kick-off values for gases/vapors
(basis: DGUV IFA Spaltenmodell)

Hazard Group	4	3	2	1
H-statements	H300, H310, H330, H340, H350, H350i, EUH032	H301, H311, H317, H318, H331, H334, H341, H351, H360F/D/FD/Fd/Df, H370, H372, EUH029, EUH031, EUH070	H302, H312, H314, H332, H361f/d/fd, H362, H371, H373, EUH071	H304, H315, H319, H335, H336, EUH066, other H-statements n.o.s., REACH Annex IV
Gases/vapors (ppm)	**0,001**	**0,01**	**0,1**	**5**

Asociación de Higiene

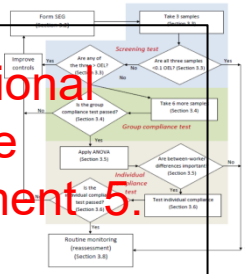
Nederlandse Vereniging voor Arbeidshygiëne

5.1.3 Prior Knowledge on Exposure (level and variability)



- Earlier measurements
- Publications
- Exposure databases: MEGA (Ge), COLCHIC & SCOLA (Fr), OSHA (USA), NEDB (UK), EXPO (NO)
- Modelling (deterministic or expert judgment)
- Read across (substance or circumstance)
- e-SDS with exposure scenarios

Occupational Exposure Assessment 5.



Initial Survey 4.

Basic characterization 5.1

5.1.1.Identification & characterization of workplace exposure sources

5.1.2 Determination of workplace exposure modifying factors

5.1.3 Estimation of workplace exposure

Not needed 5.1 — **conduct measurements ?** — **No 5.1.3**

yes

6. Document & 7.1. Periodic reassessment

6. Document

RMM

5.2.1 a priori SEG construction

5.2.2 Defining measurements within the SEG

5.3 Performing three ore more measurements

a posteriori validation of results 5.4.1 and SEGs 5.4.2

5.4 SEG and results valid?

no

yes

Change in workplace factors?

yes

no

5.5 Comparison of results with OELV

5.5 Compliance decision?

5.5.1 no-decision

5.5.2 decision

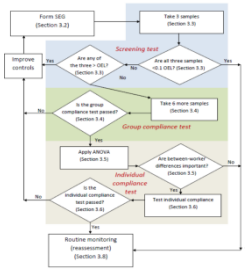
compliance

non-compliance

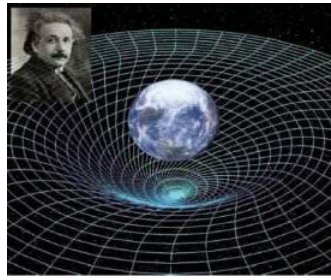
6. Detailed report and diagnostics

7.2. Periodic reassessment

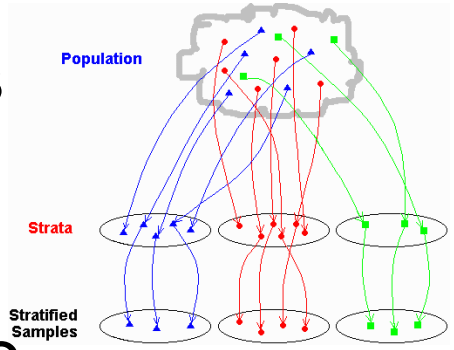
5.2 Sampling strategy



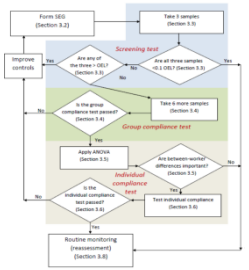
Since compliance of all workers on all shifts cannot be established, we (= industrial hygienists):



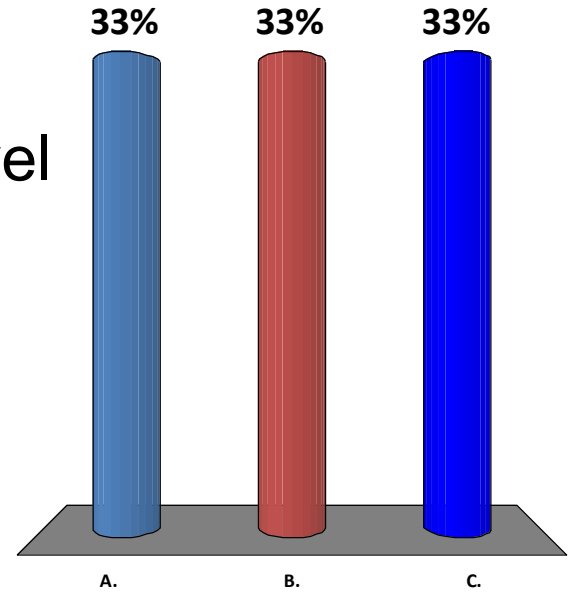
- Group workers by task/job (SEG 5.2.1)
- Use the basic characterisation to focus on substance with high potential risk
- Sample with lowest sound frequency
- Fill data gaps with Lognormal exposure distribution and uncertainty with statistics



What is a similar exposure group?



A. Workers with the same basic characterisation
B. An industrial/professional task
C. Similar job titles
D. Workers with the same exposure level

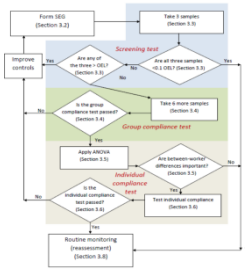


B= Reach exposure scenario,

C=Epidemiology (, German IH)

D=Occupational health (homogeneous)

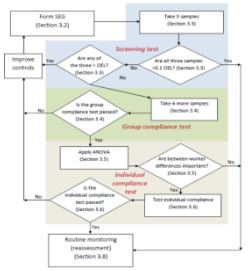
5.2.1 Similar Exposure Group (SEG)



- Workers step in and out:
  - When starting and ending their job (long term) and
  - Daily: begin and end of shift
- workers perform tasks within the shift.
- SEG activity may change (slowly) in time

Within REACH SEG's are sometimes defined as exposure scenario's (lower case)

5.2.1 Similar Exposure Group (SEG)

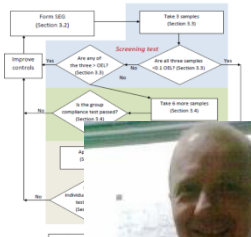


A SEG is group of workers having the same general exposure profile because of

- the similarity and frequency of the tasks they perform,
- the materials and processes with which they work, and
- the similarity of the way they perform the tasks.

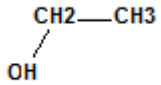
(Mulhausen et al, 1998 p 42)

SEG and exposure scenario



exposure scenario 101

OC/RMM

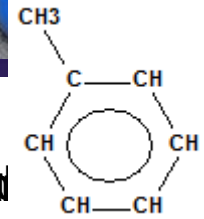


All exposure

job/task/

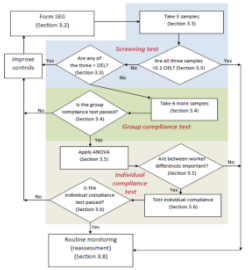
SEG

OC/RMM



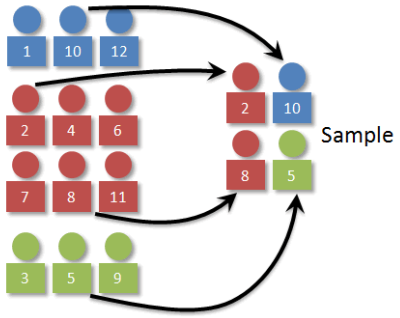
duration)

5.2.2 Sampling strategy

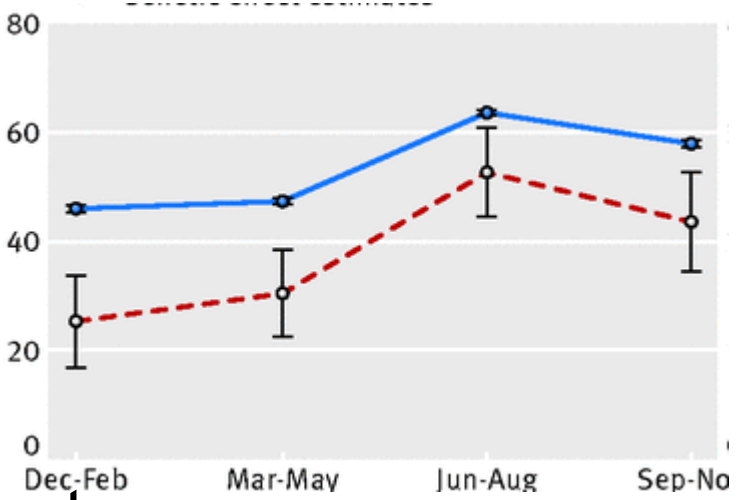


Random stratified sampling

- Within the SEG
- In time/seasons
- Between shifts

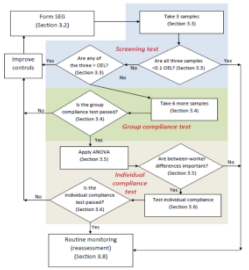


to establish the “real” exposure variability!



- EN 689: Start with 3 measurements

5.2.2 Sampling & analytical methods



(Electronic) libraries:

- Método aceptado por el Instituto Nacional de Seguridad e Higiene en el Trabajo (INSHT).
- NIOSH analytical method; (4e edition)
- OHSA Sampling & Analytical Methods
- methods of the 2e list of EU IOLV's;
- GESTIS >100 substances;

Included in DOHSBase ES (>3000)

See
http://www.tsac.nl/websites.html#Workplace_measurement_methods

Initial Survey 4.

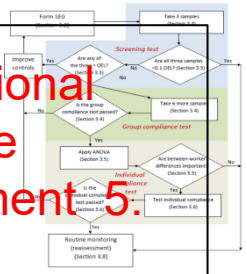
Basic characterization 5.1

5.1.1.Identification & characterization of workplace exposure sources

5.1.2 Determination of workplace exposure modifying factors

5.1.3 Estimation of workplace exposure

Occupational Exposure Assessment 5.



Not needed 5.1

conduct measurements ?

No 5.1.3

6. Document & 7.1. Periodic reassessment

6. Document

RMM

yes

5.2.1 *a priori* SEG construction

5.2.2 Defining measurements within the SEG

5.3 Performing three ore more measurements

a posteriori validation of results 5.4.1 and SEGs 5.4.2

5.4 SEG and results valid?

no

yes

Change in workplace factors?

no

yes

5.5 Comparison of results with OELV

5.5 Compliance decision?

5.5.1 no-decision

compliance

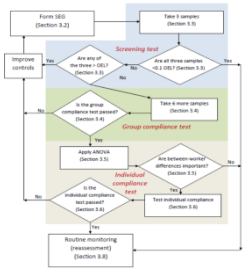
5.5.2 decision

non-compliance

7.2. Periodic reassessment

6. Detailed report and diagnostics

5.5.2 Screening test (1)

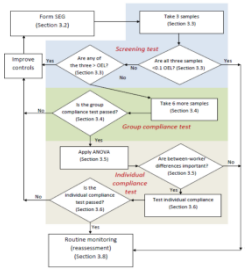


The test requires 3 to 5 exposure measurements on workers belonging to a SEG.

1. If all results are below :
   - 0,1 OELV for a set of 3 exposure measurements or;
   - 0,15 OELV for a set of 4 exposure measurements or;
   - 0,2 OELV for a set of 5 exposure measurements.

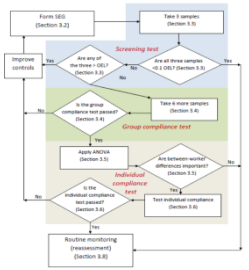
Then it is considered that the OELV is respected: **Compliance**.

5.5.2 Screening test (2)



2. If one of the results is greater than the OELV, it is considered that the OELV is not respected: **Non-compliance**.
   In case that the first measurement result is above the OELV, it is not necessary to perform any additional measurements.

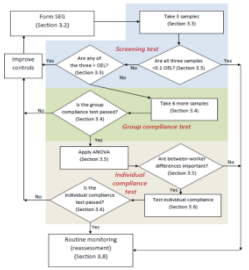
5.5.2 Screening test (3)



3. If all the results are below the OELV and a result above 0,1 OELV (set of 3 results) or 0,15 OELV (set of 4 results) or 0,2 OELV (set of 5 results) it is not possible to conclude on compliance with the OELV. **No-decision.**

In this situation it is necessary to carry out additional exposure measurements in order to apply the test based on the calculation of the confidence interval of the probability of exceeding the OELV, as specified in 5.5.2.

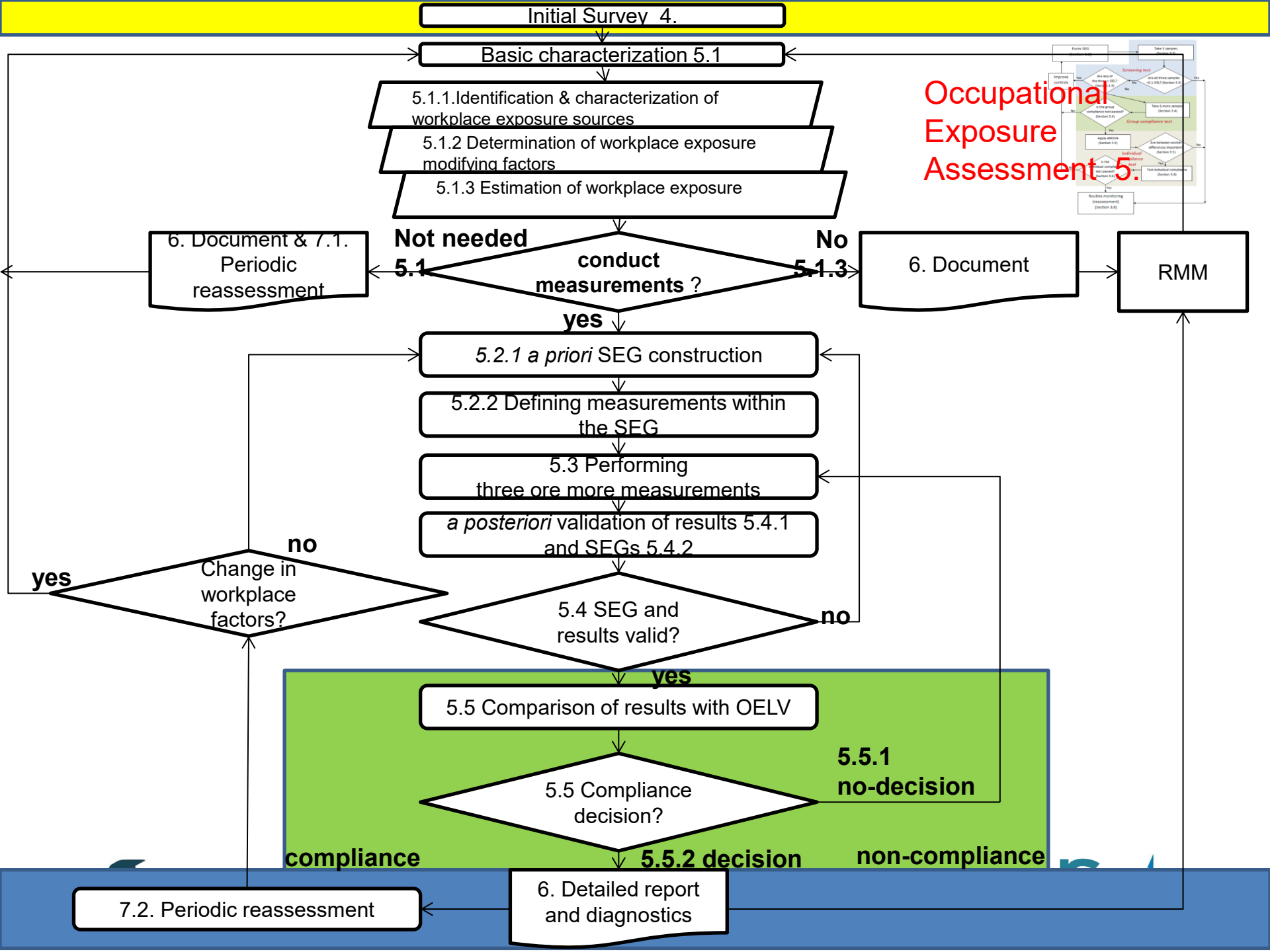
5.5.2 Confidence test



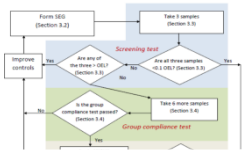
The appraiser shall select a statistical test of whether the exposures of the SEG comply with the OELV.

The test shall measure, with at least 70% confidence, whether <5% of exposures in the SEG exceed the OELV.

This afternoon

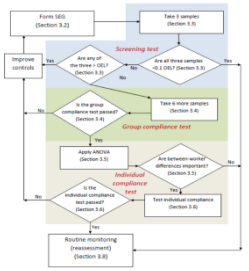

Initial Survey 4.
Basic characterization 5.1
5.1.1.Identification & characterization of workplace exposure sources
5.1.2 Determination of workplace exposure modifying factors
5.1.3 Estimation of workplace exposure
Occupational Exposure Assessment 5.
Not needed
5.1
conduct measurements ?
No
5.1.3
6. Document & 7.1. Periodic reassessment
6. Document
RMM
yes
5.2.1 a priori SEG construction
5.2.2 Defining measurements within the SEG
5.3 Performing three ore more measurements
a posteriori validation of results 5.4.1 and SEGs 5.4.2
5.4 SEG and results valid?
no
yes
Change in workplace factors?
no
yes
5.5 Comparison of results with OELV
5.5 Compliance decision?
5.5.1
no-decision
compliance
5.5.2 decision
non-compliance
6. Detailed report and diagnostics
7.2. Periodic reassessment

Agenda



When	What	Who
09:30 – 10:00	Welcome and introduction	Rudolf
10:15 – 11:00	Industrial Hygiene and EN 689 Basic characterization 5.1 Similar Exposure group (SEG) 5.2.1	Theo
11:00 – 11:15	Break	
11:15 – 12:00	Validity measurement 5.4.1 (outliers, LoQ) and the SEG 5.4.2 + Annex E & XX	Theo
12:00 – 13:00	Testing compliance 5.5 & Undetectables Differences with the current 689	Theo
13:00 – 14:00	Lunch	
14:00 – 15:00	Introduction to BW Stat v2	Tom
15:00 – 15:15	Break	
15:15 – 16:30	BW Stat v2 exercise	Tom
16:30 – 17:00	Feedback and evaluation	Rudolf

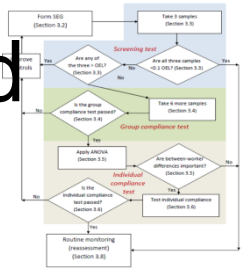
5.4 Validity of SEGs and results

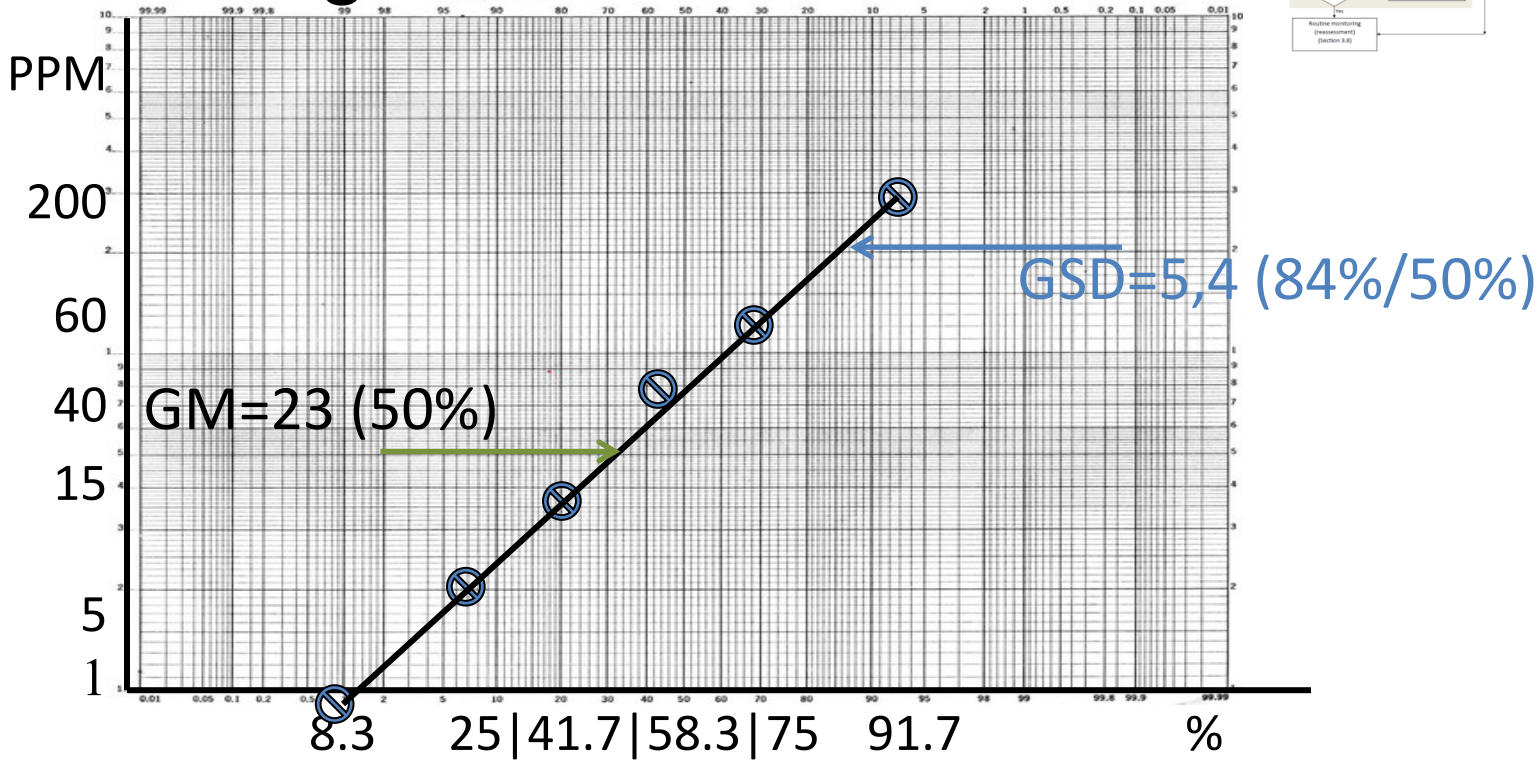


1. Lognormal goodness-of-fit (5.4.1 & Annex E)
   - Q-Q plot, shape test & best fitting transformation
2. Processing undetectables (Annex XX)
   - (fraction LoD), regression, degrees of freedom
3. GSD values (E.3.4)
   - Too low or too high: depends on activity
4. Individuals in SEG with exceptional exposure
   - Annex E.3.2
   - Location, dispersion, between and within (BWStat)

LogNormal probability paper and NOS regression

1,5,15,40,60,200 ppm





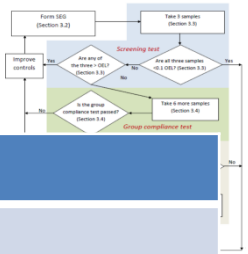
Annex E .1.1 through 1.4

Asociación Española de Higiene Industrial

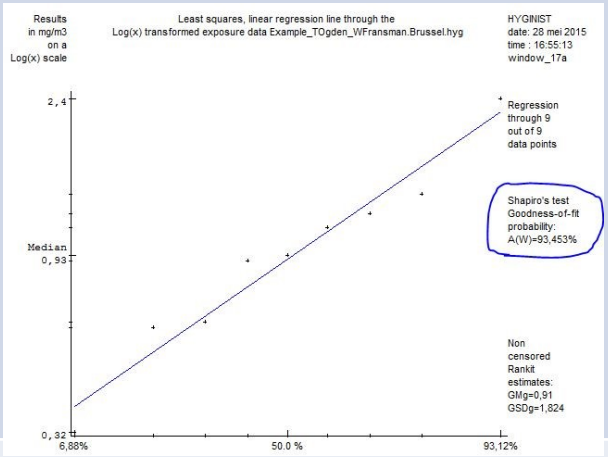
BOHS The Chartered Society for Worker Health Protection

Nederlandse Vereniging voor Arbeidshygiëne

Software goodness-of-fit plot and test (Annex E.1 and E.2)

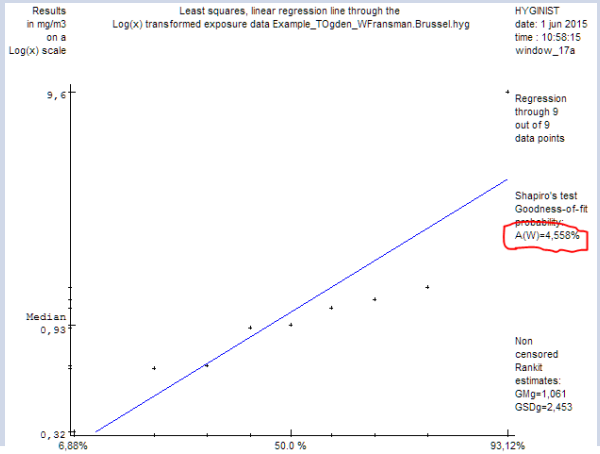


Continuous outcome



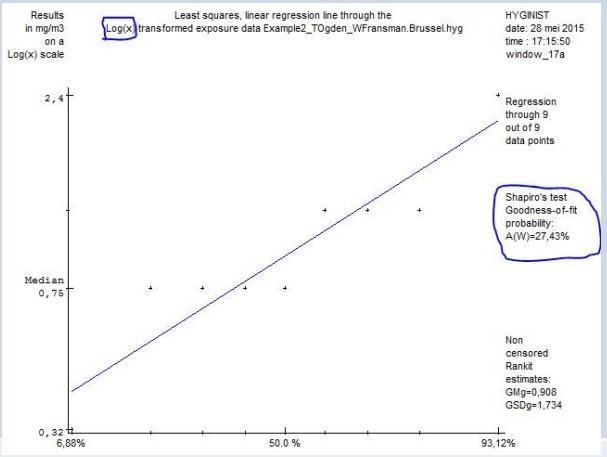
P_{SW}=93%

Single outlier (9,6 in stead of 2,4)



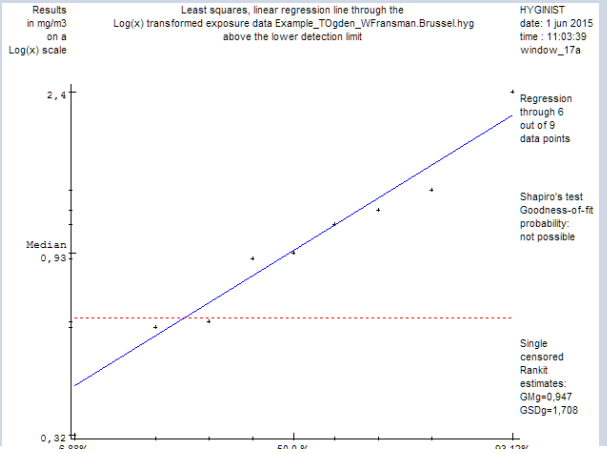
P_{SW}=4.5%

Discrete outcome



P_{SW}=27%

Detection limit



P_{SW}=n.a.

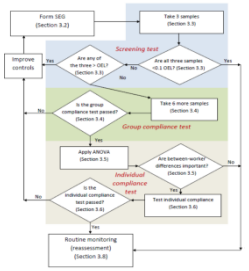
BW_Stat, HYGINIST, Altrex, IHStat

Asociación Española de Higiene Industrial

BOHS The Chartered Society for Worker Health Protection

Nederlandse Vereniging voor Arbeidshygiëne

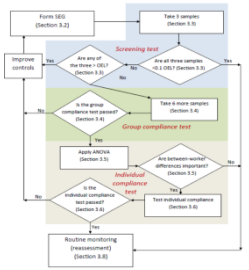
Testing log-Normal shape



- The Shapiro & Wilk test
  - Robust
  - sensitive
- What P-value to use in industrial hygiene?
  - Do not fix on say 5 %
  - compare p-values of different transformations

Included in most compliance testing software

Testing goodness-of-fit



Workplace determinants -> Lognormal

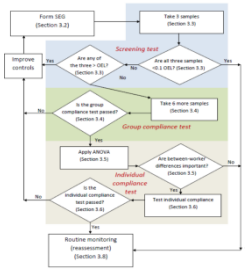
Analytical random error -> Normal

Constant high background-> Normal

Complete control -> Normal

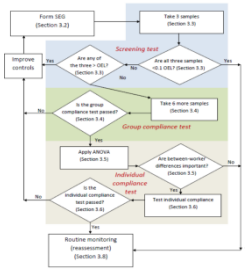
- Compare Normal vs log-Normal
- If normal fits better, then use Normal test (not in 5.5)

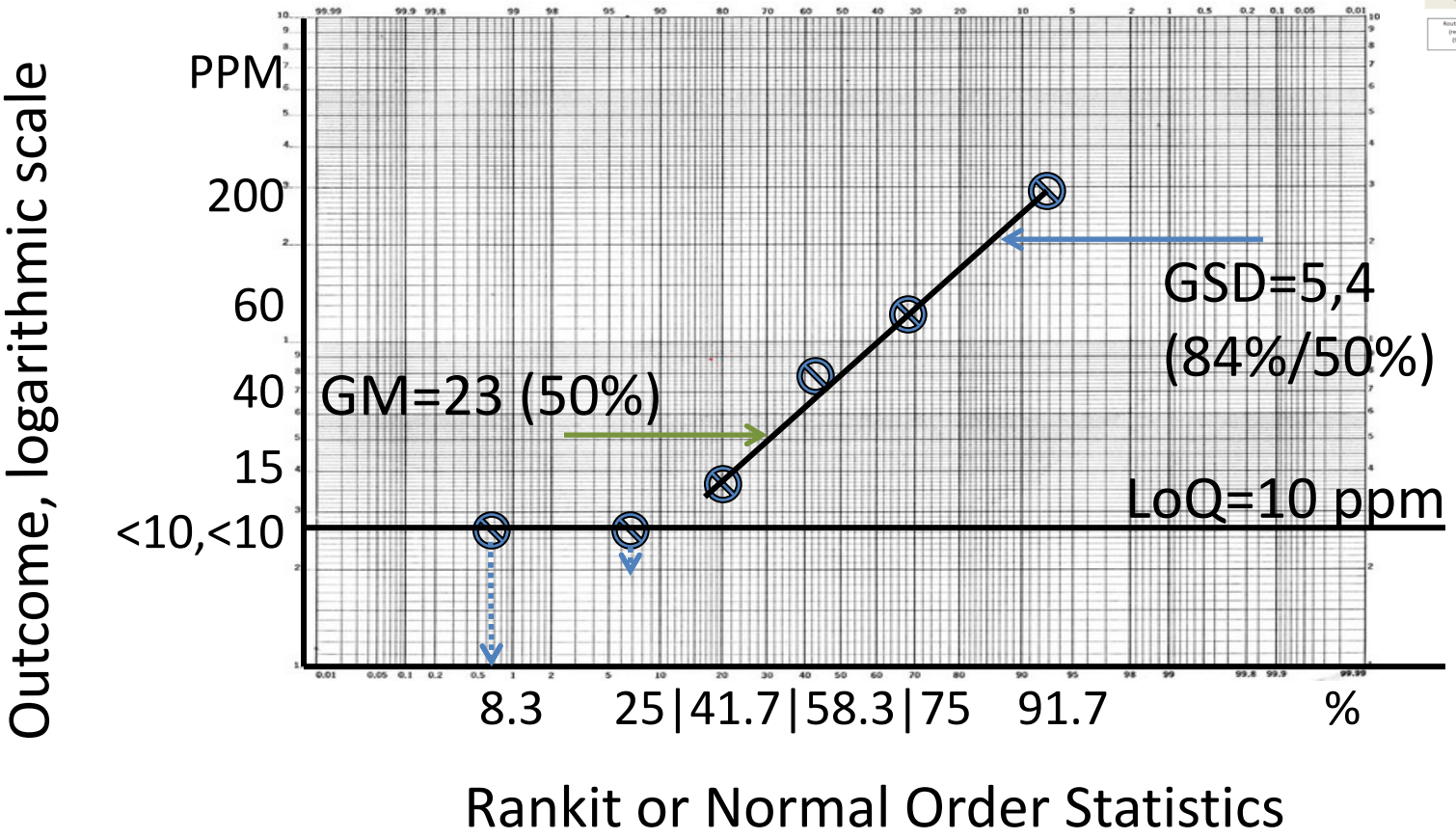
5.4 Validity of SEGs and results



1. Lognormal goodness-of-fit (5.4.1 & Annex E)
   - visual, test & transformations
2. Processing undetectables (Annex XX)
   - (fraction LoD), regression, degrees of freedom
3. GSD values (E.3.4)
   - Low or high, all is possible
4. individuals with exceptional exposure (E.3.2)
   - Location, dispersion, between and within

General principle



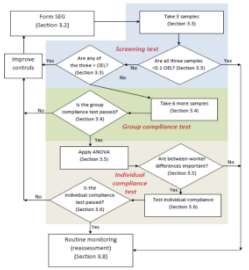


Asociación Española de Higiene Industrial

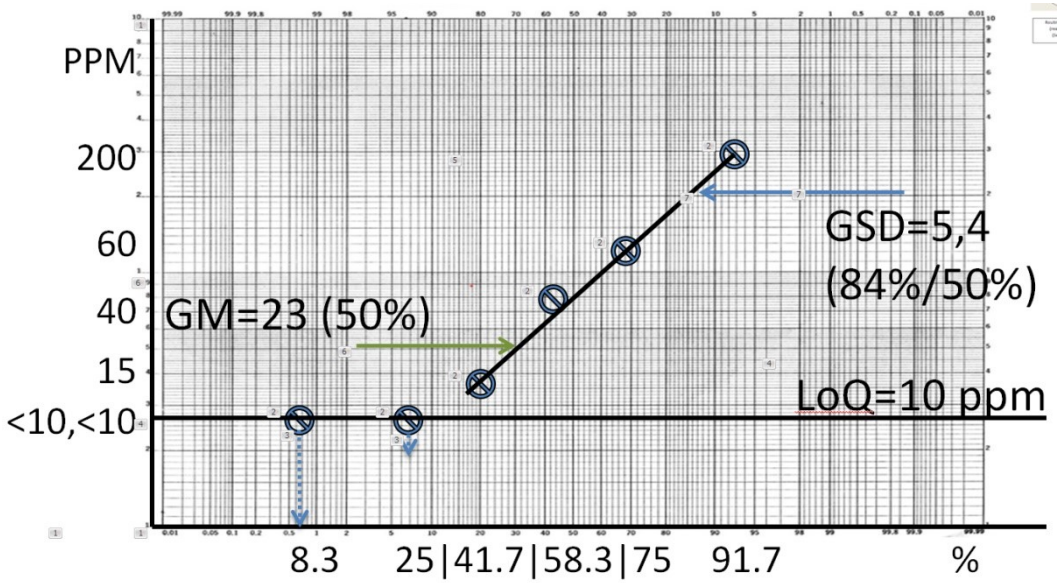
BOHS The Chartered Society for Worker Health Protection

Nederlandse Vereniging voor Arbeidshygiëne

Urgent need to treat undetectables more professionally (~~0,5*LoD~~)



- Overestimation of GM
- Underestimation of GSD and $C_{95\%}$
- Changing working patterns
- Trends in time
- IH reputation



Asociación Española de Higiene Industrial

BOHS The Chartered Society for Worker Health Protection

Nederlandse Vereniging voor Arbeidshygiëne

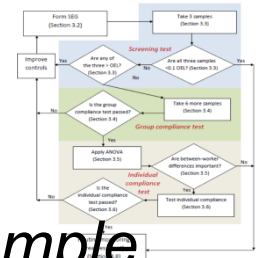
On the unbiased estimation of GM, GSD and $C_{95\%}$

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

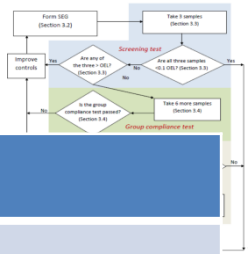
HYGINIST 4.2.3

Non-detects in Industrial Hygiene

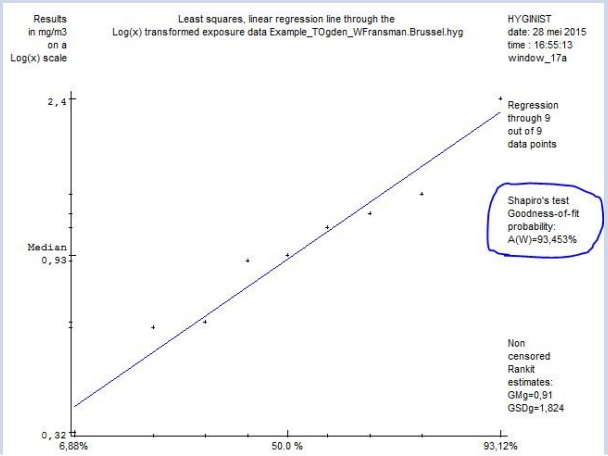


- Annals Occupational Hygiene (2009-2010, *Large sample* solutions):
  - Ogden. Editorial: Handling results below the level of detection.
  - Helsel. Incorporating Non-detects in Science.
  - Flynn. Analysis of censored exposure data by the Shapiro-Wilk W statistic.
- BOHS-NVvA guidance: “It is not recommended simply to substitute LoQ/2 or LoQ/√2 for each value<LoQ”
- Free of charge Software solutions(plot & regression): HYGINIST (1990, small samples solution), Altrex, IHDataAnalyst, NDExpo, BW_Stat (2014)

GM and GSD for different LoD

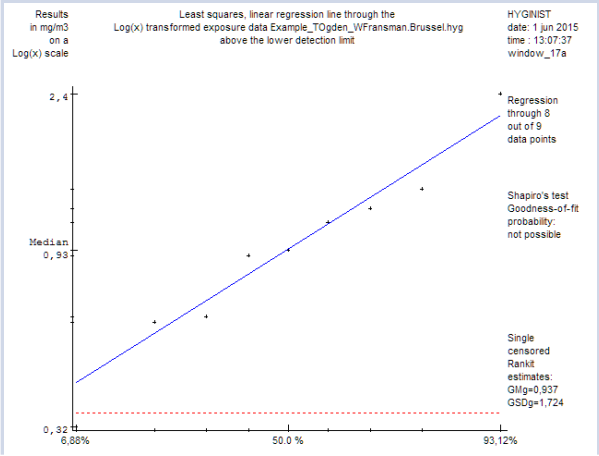


Complete sample



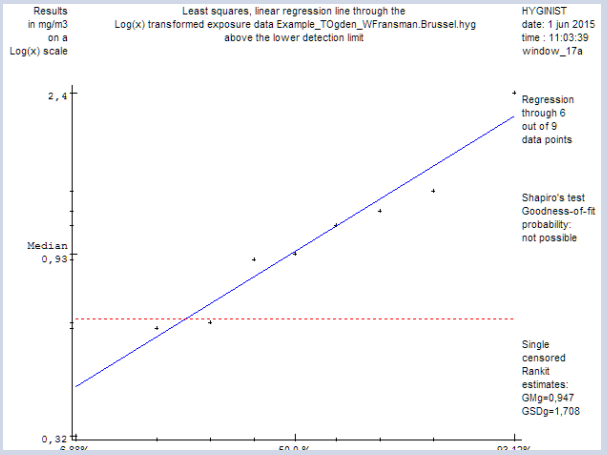
GM=0,91
GSD=1,82

One nondetect



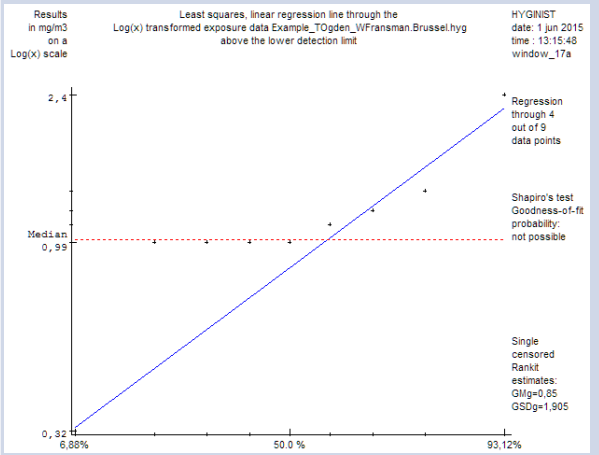
GM=0,93
GSD=1,72

Three non detects



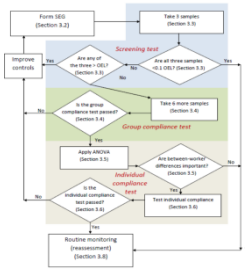
GM=0,95
GSD=1,71

Five nondetects



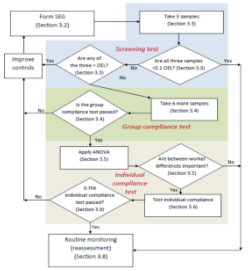
GM=0,85
GSD=1,9

5.4 Validity of SEGs and results



1. Lognormal goodness-of-fit (5.4.1 & Annex E)
   - visual, test & transformations
2. Processing undetectables (Annex XX)
   - (fraction LoD), regression, degrees of freedom
3. GSD values (E.3.4)
   - Low or high, all is possible
4. individuals with exceptional exposure (E.3.2)
   - Location, dispersion, between and within

Operational Conditions (OC) & exposure variability



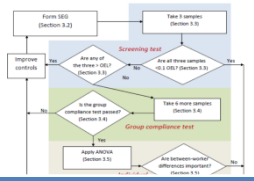
Low GSD	High GSD
Clean room, well controlled industrial OC	Outdoor, Professional OC
Job with single task	Job with multiple tasks
High background level	No background inference

Asociación Española de Higiene Industrial

BOHS The Chartered Society for Worker Health Protection

Nederlandse Vereniging voor Arbeidshygiëne

Strategy & exposure variability



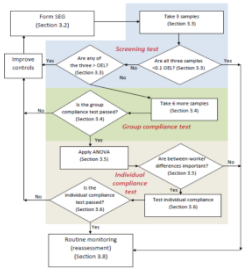
Low GSD	High GSD
Short sampling campaign (1 day, one week): autocorrelation, missing tasks	Long-term, mutually independent sampling campaign (months, year)
EM	PAS
Small sample size	Large sample size
Small detection range (Gravimetric, inorganic acids)	Broad detection range (Analytical: AAS, DPP, IC , EC, etc.)
Fixed factor or remove undetectables	Correct handling undetectables

Asociación Española de Higiene Industrial

BOHS The Chartered Society for Worker Health Protection

Nederlandse Vereniging voor Arbeidshygiëne

GSD, range, physchem & analytical



- GSD=1,5 $0,5 \leq C_{95\%} \leq 2$
- GSD=2 $0,3 \leq C_{95\%} \leq 3$
- GSD=3 $0,16 \leq C_{95\%} \leq 6$
- GSD=4,1 $0,1 \leq C_{95\%} \leq 10$
- GSD=5,4 $0,07 \leq C_{95\%} \leq 14$
- GSD=11 $0,02 \leq C_{95\%} \leq 50$
- GSD=17 $0,01 \leq C_{95\%} \leq 100$

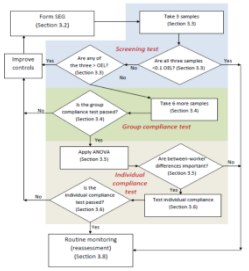
(inorg. acid mist) (gravimetric) (analytical: halogens, metals, P, N, S and solvents)

Asociación Española de Higiene Industrial

BOHS The Chartered Society for Worker Health Protection

Nederlandse Vereniging voor Arbeidshygiëne

Conclusion (E.3.4)



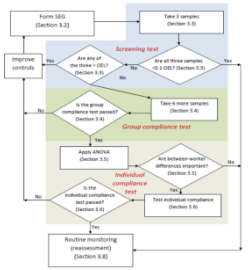
- Nearly every GSD (1.1 ->17) is possible
- Always compare GSD with what is usual for the specific situation:
  - in time
  - In large databases (Colchis, Mega)
  - Read across
  - Other industries
  - Modelling
  - Physical-Chemical properties
  - Controls

Asociación Española de Higiene Industrial

BOHS The Chartered Society for Worker Health Protection

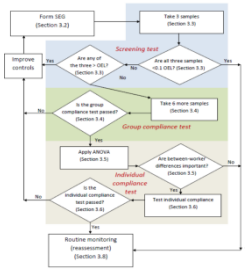
Nederlandse Vereniging voor Arbeidshygiëne

5.4 Validity of SEGs and results



1. Lognormal goodness-of-fit (5.4.1 & Annex E)
   - visual, test & transformations
2. Processing undetectables (Annex XX)
   - (fraction LoD), regression, degrees of freedom
3. GSD values (E.3.4)
   - Low or high, all is possible
4. individuals with exceptional exposure (E.3.2)
   - Location, dispersion, between and within

individuals with exceptional exposure



- This afternoon
- BW_Stat

BW_Stat Startup screen

Testing Compliance with Occupational Exposure Limits for Airborne Substances, Sept. 2011

Tab Start and Manual

Tab Data

Tab Report

Tab Examples

Manual

1. Select your language:	English	
2. Enter the name of the substance:	Cotton dust	
3. Enter the units of measurement:	mg/m³	
4. Enter the occupational exposure limit (O	1,70	mg/m³
5. Enter the lower limit of quantification (LoQ=accuracy) Also to be read out from the lognormal probability plo	0,17	mg/m³
6. Optional input of the analytical lower detection limit (L	0,04	mg/m³

7. Enter in the tab "Data" the measured concentration levels, taking following into account:
   - Make sure the unit in which the data are expressed is the same as the unit of OEL, LoQ and LoD.
   - Enter in column 2 all sampling dates (obliged input), top down, avoiding any blank cells (yellow field), maximum 50 dates allowed.
   - Enter in row 2 all worker IDs (obliged input) from left to right avoiding any blank cells (yellow fields), maximum 50 workers allowed.
   - Enter the measurements for all date/worker combinations (light blue fields); if a certain combination has no outcome, then leave this cell blank.
   - Enter the measurements <LoQ without adjustments as numeric values.
   - Background colour shifts from green (<10% OEL) via orange (=50%OEL) to red (>100%) if the measurement result shifts towards the OEL.
8. Tab Report pictures the compliance testing in four steps (stages) according to the BOHS/NVvA guidance and flowchart below.
9. Use BW_Stat only after reading the Disclaimer right to the flowchart:

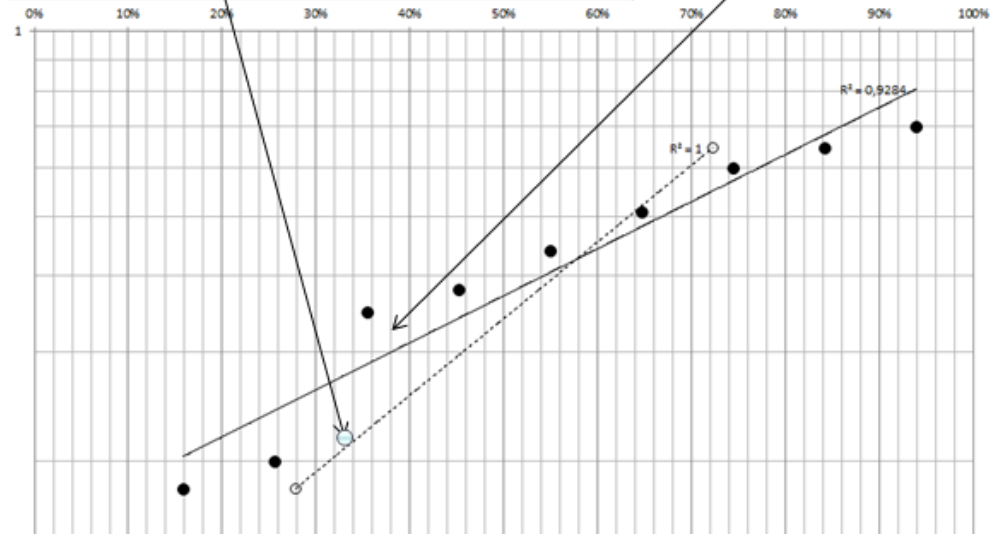
Fig.5. Flowchart of the process (from the guidance, page 19)

Disclaimer

Start & Manual / Data / Report / Examples

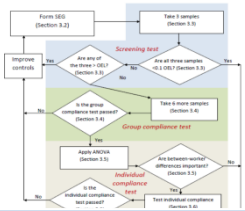
Lognormal probability plot for group and selected worker

Select a worker	Chloe
Enter maximal X-axis value	2



British Occupational Hygiene Society
Working for a healthier workplace

Compare 689 (1995 &2015) & NVVA/BOHS



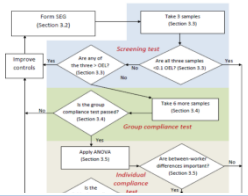
Chapter	689 (1996)	689 (2015)	NVvA/BOHS
0->4	Intro/Scope/ref/General		1
5	Exposure assessment		n.a.
5.1	Basic characterisation		n.a.
5.2	strategy		n.a
5.3	Measurements		1.2
5.4	(Mixtures)	Validity of SEG	3.2/5 Validity of SEG
5.5	Compliance: Yes, no and in between -> annexes B, C, D & E	Screening test & Group compliance Annex F	3.3 Screenings test 3.4 Group compliance 3.6 Individual compliance
	-	Annex XX 5.5.2 with <LoQ	3.7 values <LoQ

Asociación Española de Higiene Industrial

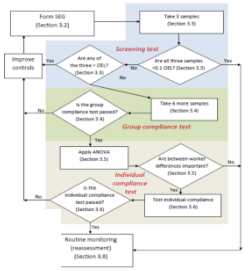
BOHS The Chartered Society for Worker Health Protection

Nederlandse Vereniging voor Arbeidshygiëne

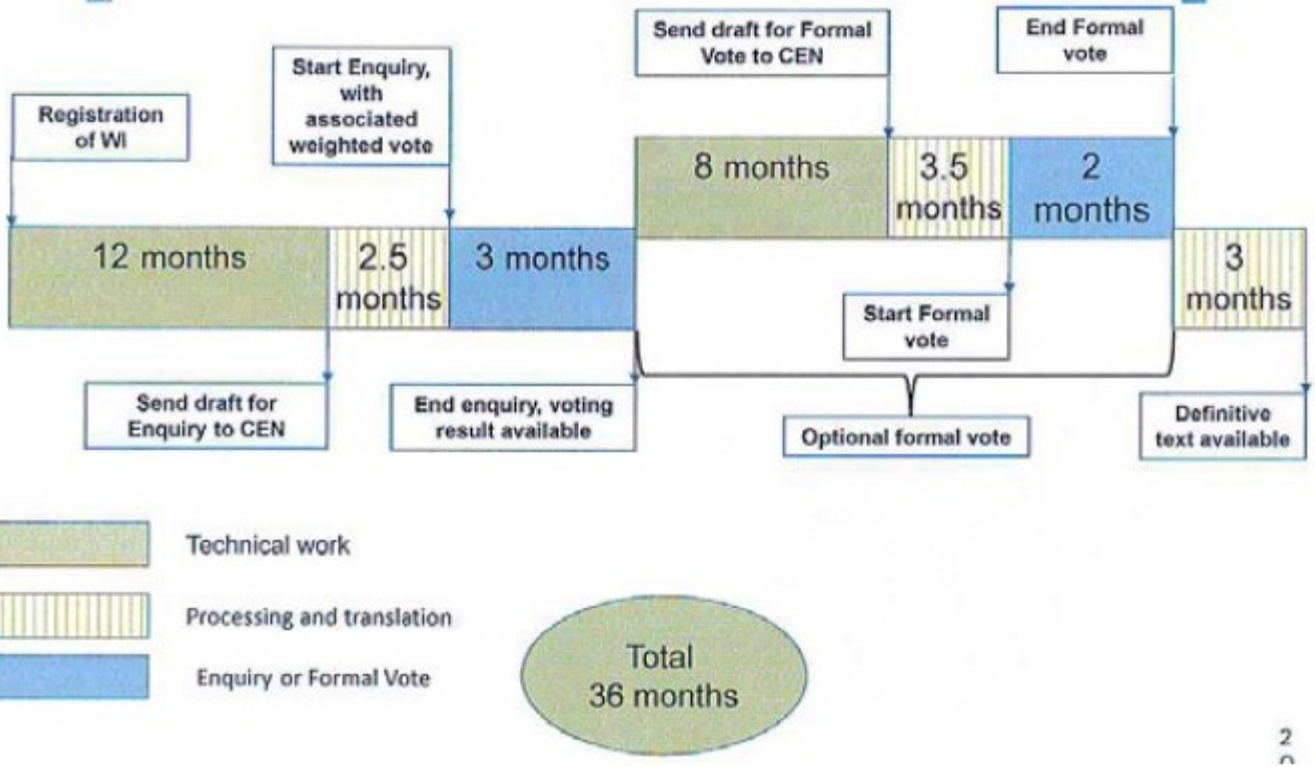
Comparison of results with OELVs



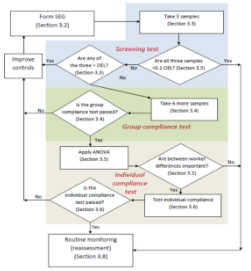
test	689 (1996)	689 (2015)	NVvA-BOHS (3)
screening	n.a.	3 samples <0,1 OELV 4 samples <0,15 OELV 5 samples <0,2 OELV	3 samples <0,1 OELV
confidence	n.a.	6+ samples C95%,70%<OELV	6+ samples , several workers C95%,70%<OELV
Between Worker differences	n.a.	(5.4. + Annex E)	ANOVA test on individual outside SEG If, so ↓
Within Worker compliance	n.a.	n.a	Individual compliance



Detailed Timeframe European Standard



In summary



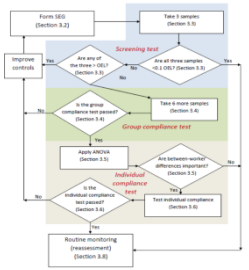
Advantages of EN 689:

- Standardized approach
- Broad acceptance
- “No questions asked” execution
- Freedom to do it different, if motivated

Additional advantage of BOHS-NVvA guidance

- Distinguish between improvement of technical and individual control meassures

The presenters



- Theo Scheffers
  - theo.scheffers@tsac.nl
- Tom Geens
  - tgeens@gmail.com