

Testing compliance with occupational exposure limits (OELs) for airborne substances: the new revision of European Standard EN 689

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Elements of controlling exposure to airborne substances:

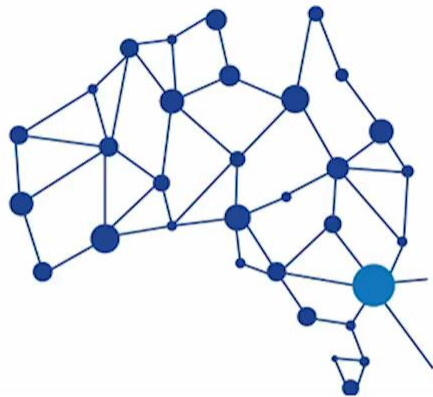
1. Principles of occupational hygiene*
 - COSHH Reg 7 (3), (4), (5) & Schedule 2A
2. “Seek continual improvement”
 - John Cherrie
 - <https://www.youtube.com/watch?v=eASLhprRBcA>
3. Do not allow an OEL to be exceeded*
 - COSHH Reg 7(7b)

**reflecting the Chemical Agents and the Carcinogens Directives*



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NATIONAL CONVENTION CENTRE, CANBERRA

European Law:

Chemical Agents Directive: as soon as the limit is exceeded, *“the employer shall immediately take steps...”*

Carcinogens Directive: *“Exposure shall not exceed the limit value”*

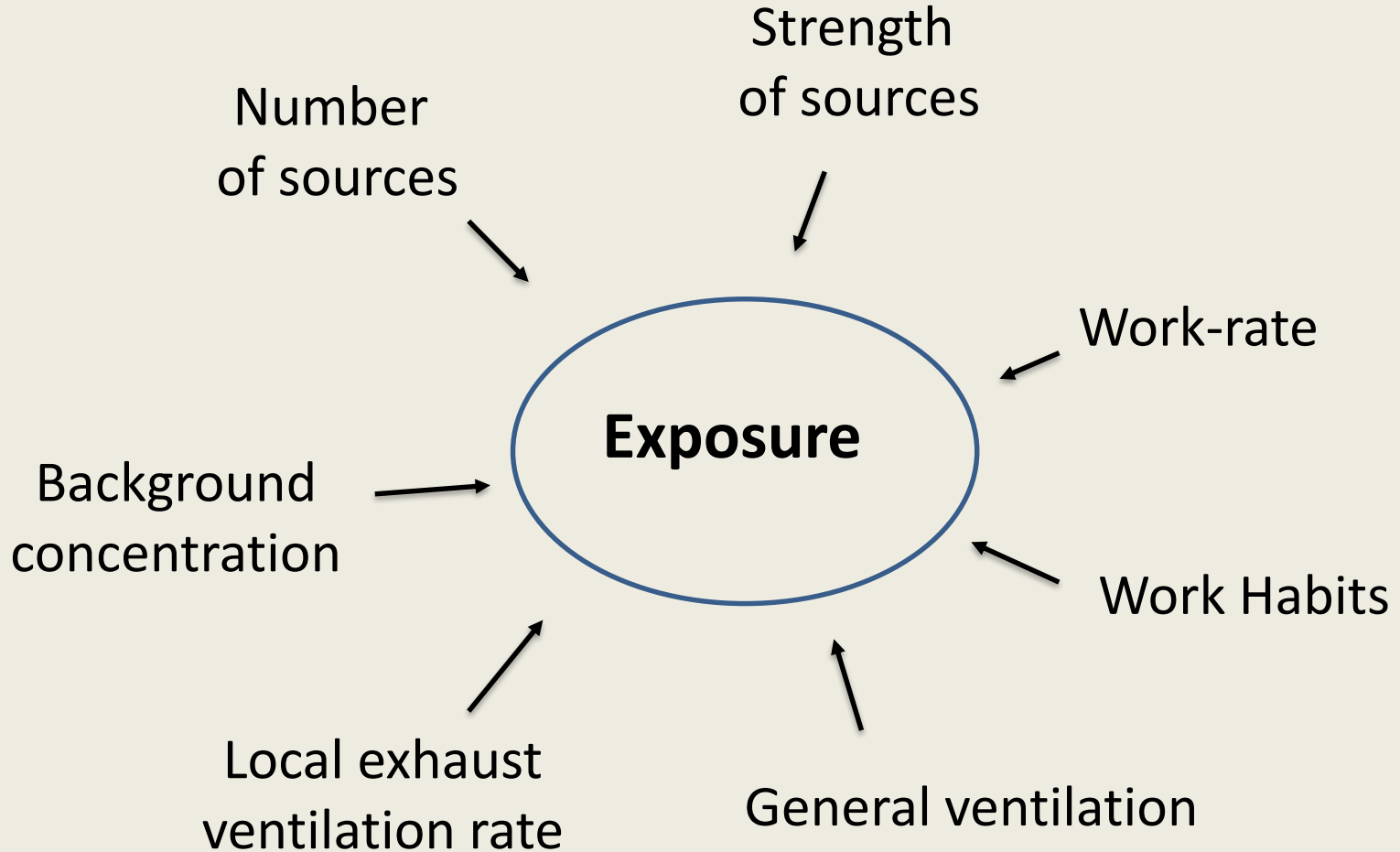
Exposure averaged over the reference period of the exposure limit **must not be exceeded.**

An enforcer just needs one valid result $>OEL$ to show that the law is broken

If an employer gets a result $<OEL$, it only shows that the OEL is complied with at the time and place that the measurement is made.

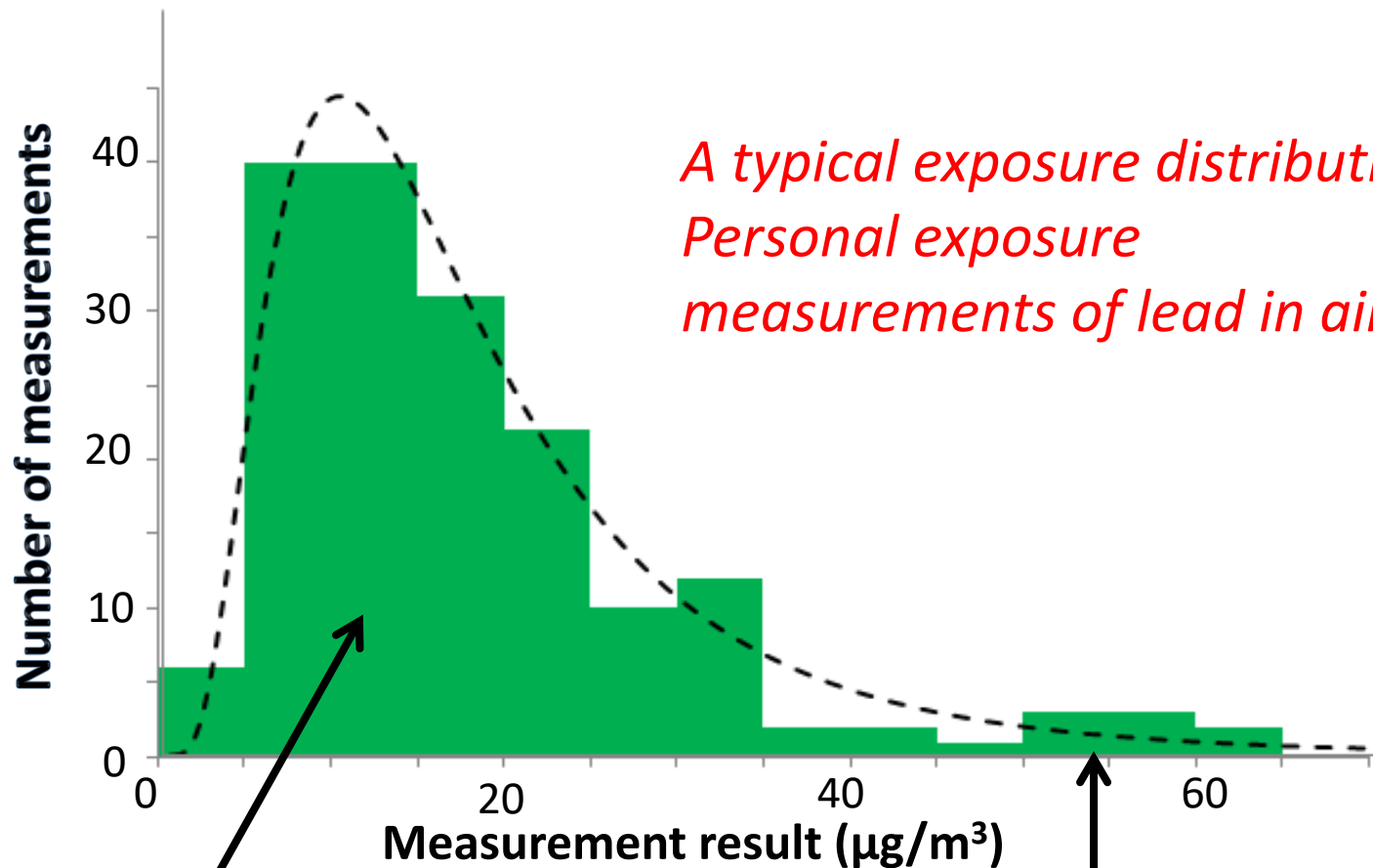
How many measurements does an employer have to make, and how far below the OEL do they have to be, to be confident that at least 95% of exposures are $<$ OEL?





Exposure level results from the interplay of many factors

The problem:



*A typical exposure distribution:
Personal exposure
measurements of lead in air.**

Most exposures will be in this region...

... but sometimes exposures are much higher

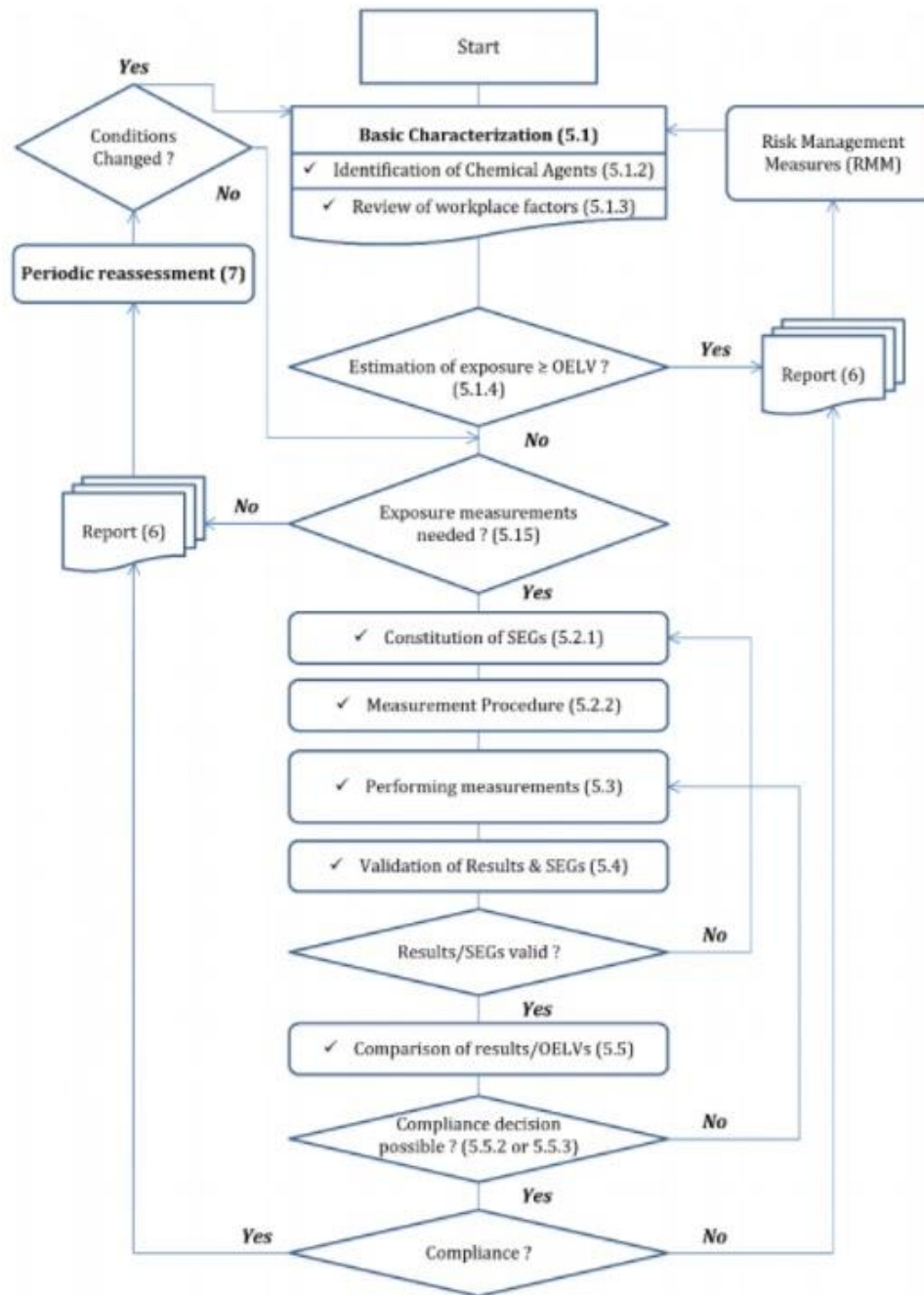
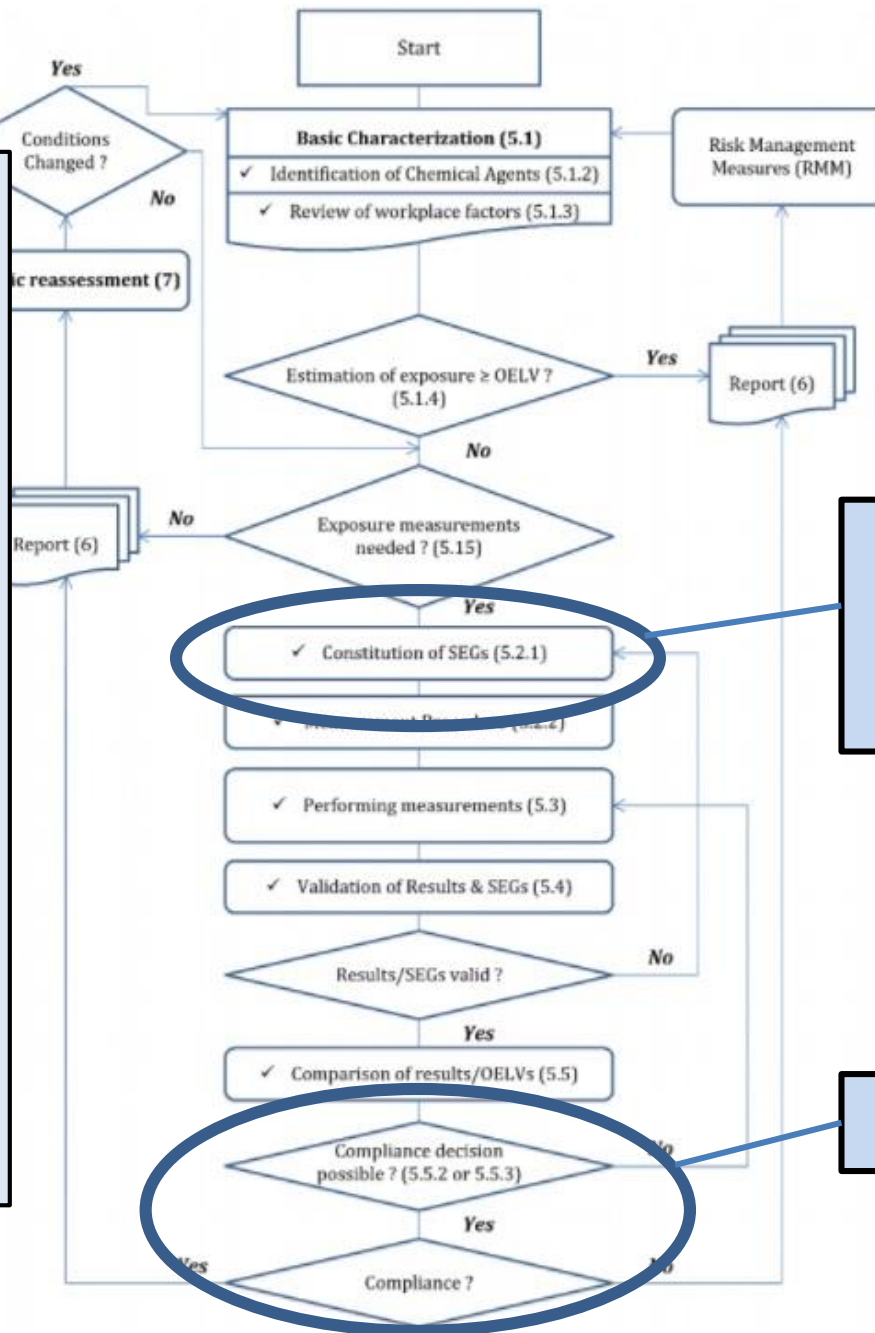


Figure 1 — Schematic overview of the strategy

Must be conducted by an “appraiser”, a person “who is sufficiently trained and experienced in occupational hygiene principles, working and measurement techniques, to conduct the part of the assessment he or she is performing according to the state of the art”



Work with similarly Exposed Groups (SEGs)

Test compliance

Figure 1 — Schematic overview of the strategy

Test compliance:

1. Preliminary test with 3-5 measurements
To quickly identify SEGs that clearly comply
2. Statistical test
Fuller test requiring more measurements

Preliminary test

Make three measurements from SEG

If all results $< 0.1 \times \text{OELV}$

Or make four measurements

If all $< 0.15 \times \text{OELV}$

Or make five measurements

If all $< 0.2 \times \text{OELV}$

Then conclude:
Compliance

Based on computer simulations of lognormal distributions by INRS

If any results at this or any other stage $> \text{OELV}$ – then conclude
Non-compliance

The preliminary test is in the text of the standard

If no decision can be reached with the Preliminary Test:

Statistical test

If all results are $<$ OELV but the screening test is not met, then

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 less than 5 % of exposures in the SEG exceed the OELV.

**If any results at this or any other stage $>$ OELV – then conclude
Non-compliance**

This specification is in the Standard; an EXAMPLE of a suitable test is in an Annex

Example of statistical test (Annex F)

Calculate *Geometric Mean* and *Geometric Standard Deviation*

$$\ln(GM) = \frac{\sum_1^n \ln(x_i)}{n}$$

$$\ln(GSD) = \sqrt{\frac{\sum_1^n (\ln(x_i) - \ln(GM))^2}{n-1}}$$

and U_R

$$U_R = \frac{\ln(OELV) - \ln(GM)}{\ln(GSD)}$$

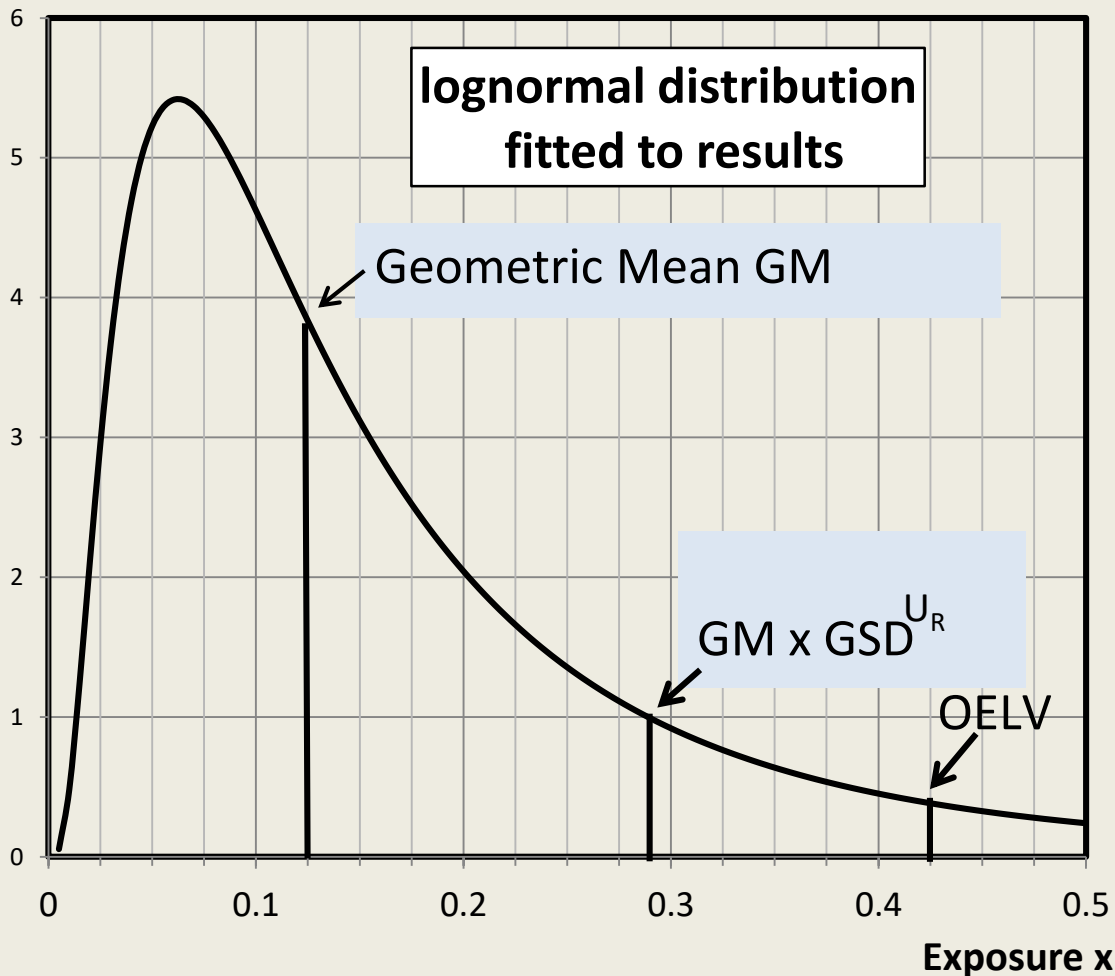
Compare U_R as calculated with a critical value U_T from a table

Table F.1 — U_T values depending on the number of results of exposure measurements

| Number of exposure measurements n | U_T | Number of exposure measurements n | U_T | Number of exposure measurements n | U_T |
|--|-------|--|-------|--|-------|
| 6 | 2,187 | 15 | 1,917 | 24 | 1,846 |
| 7 | 2,120 | 16 | 1,905 | 25 | 1,841 |
| 8 | 2,072 | 17 | 1,895 | 26 | 1,836 |
| 9 | 2,035 | 18 | 1,886 | 27 | 1,832 |
| 10 | 2,005 | 19 | 1,878 | 28 | 1,828 |
| 11 | 1,981 | 20 | 1,870 | 29 | 1,824 |
| 12 | 1,961 | 21 | 1,863 | 30 | 1,820 |
| 13 | 1,944 | 22 | 1,857 | - | |
| 14 | 1,929 | 23 | 1,851 | | |

If $U_R > U_T$ then, decision is *Compliance*

Frequency of exposure x



Annex F tests whether

$$GM \times GSD^{UR} < OELV$$

A standard is authoritative advice.

It does not have legal status unless there
is a regulation requiring its use

HSE COSHH Essentials Guidance G409. Exposure Measurement:
Air Sampling

“If the results for a given task are below one third of the exposure limit, your controls are probably good enough.”

This is probably OK if you have at least 4 measurements in a SEG, but to reach a similar standard of proof to the preliminary test you would need 12 measurements.

Justification for preliminary test:

GRZEBYK M., SANDINO J.P. Aspects statistiques et rôle de l'incertitude de mesurage dans l'évaluation de l'exposition professionnelle aux agents chimiques. INRS, ND 2231, Revue Hygiène et sécurité du travail, 09/2005

<http://www.inrs.fr/media.html?refINRS=ND%202231>

Justification of the compliance test used in Annex F:

OGDEN T.L., LAVOUÉ J. Testing Compliance with Occupational Exposure Limits: Development of the British-Dutch Guidance J Occ Env Hyg 9:D63-D70 (2012)

<http://www.tandfonline.com/doi/full/10.1080/15459624.2012.663702>

Summary of the standard:

OGDEN T.L. The revised European Standard EN689: Testing compliance with exposure limits. *Exposure* 2017 issue 4, pp 16-20

https://www.academia.edu/36310697/Testing_Compliance_with_Occupational_Exposure_Limits_-_2017_revision_of_EN_689.pdf

(or go to Academia.edu and search for Trevor Ogden)