


HSE Health and Safety Executive

The technical basis for COSHH essentials: Easy steps to control chemicals



Introduction

1 This report summarises the technical basis of the generic risk assessment scheme used in the Health and Safety Executive's (HSE's) guide COSHH essentials: Easy steps to control chemicals.¹ It replaces the previous publication The technical basis for COSHH essentials (ISBN 0 7175 2634 0) and partly replaces publication HSG153.¹ It complements and updates the articles published in the *Annals of Occupational Hygiene*.^{2,3*}



Validation of the Hazard Grouping in Control Banding

Finding the best hazard grouping to establish “Kick-off” levels (next presentation)

IFA
Institut für Arbeitsschutz der Deutschen Gesetzlichen Unfallversicherung

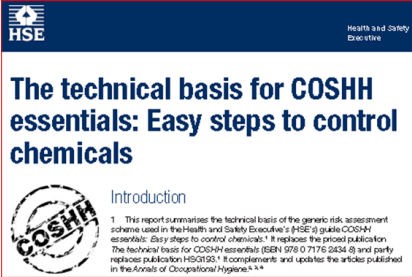
Das GHS-Spaltenmodell

Theo Scheffers,
Geert Wieling,
Caroline Coucke.

**Einfaches Maßnahmenkonzept
Gefahrstoffe**



Modul



Control Banding (CB)

a generic technique for assessing and managing workplace exposure risks:

- without the use of an Occupational Exposure Limit Value (OELV)
- with the use of grouped Health Hazard Identifiers like the EU R-phrases or EU/GHS H3##-statements



Identified Control Banding schemes (1)

HSE Health and Safety Executive

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new version of TRGS 600 supersedes

Substitution

Hazardous Substances

Einfaches Maßnahmenkonzept Gefahrstoffe



Modul

INTERNATIONAL LABOUR OFFICE

PROGRAMME ON SAFETY AND HEALTH AT WORK AND THE ENVIRONMENT

SAFEWORK

INTERNATIONAL CHEMICAL CONTROL TOOLKIT

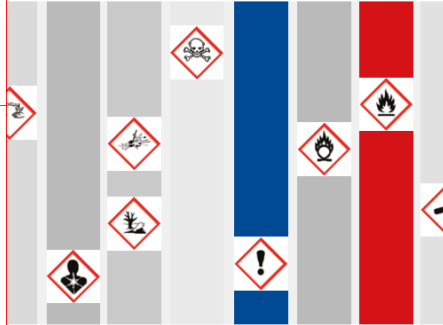
ECHA EUROPEAN CHEMICALS AGENCY

GUIDANCE

Guidance on information requirements and chemical safety assessment

Part E: Risk Characterisation

IFA Institut für Arbeitsschutz der Deutschen Gesetzlichen Unfallversicherung



Das GHS-Spaltenmodell



Identified CB Schemes (2)

- 7 R-Phrases based CB schemes,
 - R-phrases will be phased out in 2015
- REACH CSA Part E, limited # H-statements
- ILO Toolbox with GHS classifications
- NIOSH Exposure banding process
- 3 CLP H-Statements based CB schemes are enrolled
 - See next slide

HSE Health and Safety Executive

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Einfaches Maßnahmenkonzept Gefahrstoffe

Modul

IFA Institut für Arbeitsschutz der Deutschen Gesetzlichen Unfallversicherung

Das GHS Spaltenmodell

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GUIDANCE

Guidance on information requirements and chemical safety assessment

Part E: Risk Characterisation

TRGS 600 Page - 1 -

The new version of TRGS 600 supersedes TRGS 440.

Edition: August 2008

| Technical Rules for Hazardous Substances | Substitution | TRGS 600 |
|--|--------------|----------|
| The Technical Rules for Hazardous Substances (TRGS) reflect the state of technology, occupational safety and health and occupational hygiene as well as other scientific knowledge relating to the requirements concerning the placing on the market and handling of hazardous substances. The | | |

Committee on Hazardous Substances (AGS)

H-statement based schemes selected

- COSHH Essentials (HSE: Health and Safety Executive)
- einfaches Maßnahmenkonzept Gefahrstoffe (EMKG) (BAuA: Federal Institute for Occupational Safety and Health). Separated hazard grouping for skin route
- GHS Spaltenmodell; based on TRGS600 (DGUV IFA: Institute for Occupational Safety and Health of the German Social Accident Insurance)



Validation (1) theoretical base

- H-statements are a qualitative and quantitative mix
 - 2 to 6 dose levels: toxicity, different routes (H300->32 acute; H370->373 repeated)
 - 1 or 2 Severity levels: irritation, corrosive, sensitization
 - 3 to 5 levels weight of evidence as human health hazard: Carcinogenic, Mutagenic, Reprotoxic
 - Special single warnings: lactation
 - Examples : next slide

Grouping of H-statements, resulting in an ranked measure.
What kind of ranking?



Health hazard grouping (simplified)

| Hazard category | Health Hazard Identifiers (HHI) like R-phrases, H- & EUH statements and REACH & CMR classifications (IARC, etc.) |
|-----------------|--|
| 5/E | Human Carcinogen R45, 49, H350(i), IARC 1, 2a |
| 4/D | Very toxic, R26, H330, Possible Carc. R40, H351 , IARC 2b. |
| 3/C | Toxic R23,H331, Corrosive 34, 35, H314, EUH071 |
| 2/B | Harmful R20, H332; Irritation R37, H335 |
| 1/A | Harmless. R36, 38; REACH non ES obligation, Annex IV |

Increasing hazard group # lead in a CB scheme to a more structural & stringent control regime



R-phrases and H-statements don't match !

Acute toxicity: LD50 – oral mg/kg

| Dose mg/kg | R-phrase | hazard group | CLP hazard class & category | H-Statement | Hazard group |
|------------|----------|--------------|-----------------------------|-------------|--------------|
| <5 | 28 | D | Acute Tox 1 | 300 | D |
| 5-25 | 28 | D | Acute Tox 2 | 300 | D |
| 25-50 | 25 | C | Acute Tox 2 | 300 | D |
| 50-200 | 25 | C | Acute Tox 3 | 301 | C |
| 200-300 | 22 | B | Acute Tox 3 | 301 | C |
| 300-2000 | 22 | B | Acute Tox 4 | 302 | B |

Conclusions theoretical base

- There is no theoretical base for an allocation in 3 to 5 ordered hazard groups
 - Endpoint of health hazard statements are mutually independent
 - Endpoint with >1 H-statement : discrete (tox), ordinal or categorical (CRM) related
- R-phrase and H-statement based hazard grouping differ
- 50 EU health R-phrases and 38 H3##/EUH## health statements based on 84 classification criteria
 - Most CB schemes do not take the classification differences between R-phrases to H-statement into account.
 - Substances may end up in a different hazard group when switching from an R-phrase to H-statement based Control Band Scheme

Validation (2) reproducibility

If H-statements cannot be grouped theoretically what is the reproducibility of different hazard groupings?

In an experimental setting: repeated, independent trails must result in the same outcome

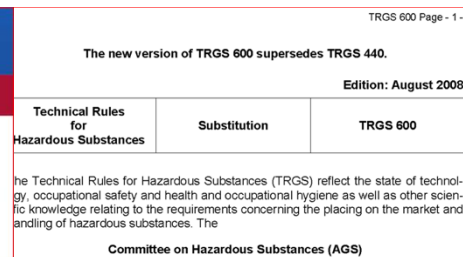
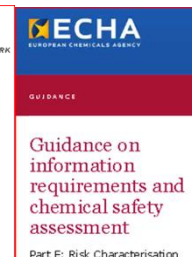
- multiple institutions throughout the world have performed hazard grouping (more or less independent)

Reproducibility: differences in allocating H-statements

| Hazard category | DGUV IFA Spaltenmodell | HSE COSHH Essentials | BAUA EMKG (Einfaches Maßnahmenkonzept) (inhalation) |
|-----------------|---|---|--|
| 5/E | H300, H310, H330, EU032 H340 (AGS Mut 1AB) H350, H350i (AGS K1/2 & TRGS 906) | H334, H340, H341, H350, H350i | H340, H350, H350i, H360F (TRGS 905 & 906) |
| 4/D | H301, H311, H331 EUH070, EUH029, EUH031 H370, H317 (Sh), H334 (Sa), H318 H360 _{xy} (AGS R _{EF} 1/2) H351 (AGS K3), H341 (AGS M3), H372 | H300, H310, H330 H351, H360 _{xy} , H361, H362, H372 | H300, H330, H360D, H372, EUH032 |
| 3/C | H302, H312, H332 H314 (pH ≥ 11,5, pH ≤ 2), H371, EUH071 H361 _{f/d} , H373, H362 non-toxic gases which may cause asphyxiation | H301, H311, H331, H314, H317, H318, H335, H370, H373, EUH071 | H301, H331, H314, H334, H341, H351, H361f/d, H370, H371, H373, EUH031 (TRGS 907) |
| 2/B | H315, H319 damage to the skin during wet work H304, EUH066, H335, H336 Substances chronically harmful in other ways (no H-statement, but still hazardous) | H302, H312, H332 H371 | H302, H332, H318 |
| 1/A | substances which experience shows to be harmless (e.g. water, sugar, paraffin etc.) | H303, H304, H305, H313, H315, H316, H319, H320, H333, H336, EUH066 and all H-numbers not otherwise listed | H319, H335, H336, H304 No health hazard H-statements |

Reproducibility of CB hazard grouping

- CB hazard grouping is a combination of:
 - Basic toxicological knowledge
 - Professional judgement
 - Risk perception
 - National sentiment
 -
- The reproducibility of CB hazard grouping is limited



Validation (3): compare with standard

- A “golden” standard does not exist
- OELVs are used to validate hazard grouping
 - OELV is a quantitative measure
 - Substances with both OELV and HHI exists
- Is anybody in the audience aware of a better standard ? (afterwards)

DOHSBase Compare
www.dohsbase.com

172000 substances
225000 synonyms
40000 PhysChem properties
8000 harmonized CLPs
3800 OELV
2000 Kickoff levels
2000 REACH DN/MELs
2500 analytical methods

| Name | Sampling method | Principle of |
|----------------------------------|--|--------------|
| Isotriandioxyanaat | MDHS 25/3 related method BIA 7670 | Active |
| Isotriandioxyanaat | MDHS 25/3 related method BIA 7670 | Active |
| Hexamethyleendioxyanaat | MDHS 25/3 related method BIA 7670 | Active |
| Beryllium metaalisch | MDHS 29/2 | Active |
| Cobalt | MDHS 30/2 | Active |
| Dioxychloorsilicium | MDHS 32 | Active |
| Dioxychloroform | MDHS 32 | Active |
| Fluorides, inorganic and soluble | MDHS 35/2 | Active |
| Fluorwaterstof | MDHS 35/2 | Active |
| Fluorwaterstof | MDHS 35/2 | Active |
| Fluorides, inorganic and soluble | MDHS 35/2 | Active |
| Silica, crystalline (Quartz) | MDHS 38 respiabel stof ger. meth. BIA 8522, NIOSH 7602 | Active |
| Platina metaalisch | MDHS 46/2 | Active |
| Platinaoxyden, water oplosbaar | MDHS 46/2 | Active |
| Butadieen(1,3) | MDHS 53/2 | Active |
| Fullerenes, tubular | MDHS 59 fibres | Active |
| Glasvezels, superfin | MDHS 59 fibres | Active |



Database with hazard groups & OELV

| NAME | MG_M3 | PPM | Reference | SOR | STATE | EMKG_HO | IFA_SPLT_H | COSHH_H | H_PHRASES |
|------------------------------|-------|-------|-----------------------------|-----|--------------|---------|------------|---------|--|
| Aluminium | 4 | | DFG 2013, Mitteilung 49 | 301 | Solid | | 1 | 1 | 1 H261 H228 |
| Aluminum chloride | 0,05 | | Gr 2009/02OSH | 201 | Solid | | 4 | 3 | 4 H314 |
| Tetraethylorthosilicaat | | 1,2 | Gr 2000/15OSH131 | 201 | Liquid | | 2 | 2 | 3 H226 H332 H319 H335 |
| Tetraethylsilicaat | | 5 | SCOEL-SUM 064 | 211 | Liquid | | 2 | 2 | 3 H226 H332 H319 H335 |
| Fosfor, wit en geel | 0,01 | | DFG 2013, Mitteilung 49 | 301 | Solid | | 4 | 4 | 4 H250 H330 H300 H314 H400 |
| Fosfortrichloride | | 0,3 | 2013 TLVs and BEIs with 7th | 311 | Liquid | | 4 | 4 | 4 H330 H300 H373** H314 |
| Fosforyltrichloride | | 0,1 | 2013 TLVs and BEIs with 7th | 311 | Liquid | | 4 | 4 | 4 H330 H372** H302 H314 |
| Fosforpentoxide | 1 | | SEG-SUM 014 EUR-15091: 39-4 | 111 | Solid | | 3 | 2 | 3 H314 |
| Tributylfosfaat | | 0,18 | 2013 TLVs and BEIs with 7th | 201 | Solid/Liquid | | 4 | 3 | 4 H351 H302 H315 |
| Tributyl phosphate | 5 | | 2013 TLVs and BEIs with 7th | 311 | Solid/Liquid | | 4 | 3 | 4 H351 H302 H315 |
| Triorthocresylfosfaat | 0,1 | | 2013 TLVs and BEIs with 7th | 311 | Liquid | | 3 | 3 | 3 H370** H411 |
| Dichloorvos | | 0,11 | DFG 2013, Mitteilung 49 | 301 | Solid/Liquid | | 4 | 4 | 4 H330 H311 H301 H317 H400 |
| Mevinfos | 0,01 | | 2013 TLVs and BEIs with 7th | 311 | Solid/Liquid | | 4 | 4 | 4 H310 H300 H400 H410 |
| Mevinfos | | 0,01 | DFG 2013, Mitteilung 49 | 301 | Solid/Liquid | | 4 | 4 | 4 H310 H300 H400 H410 |
| Trichloorfon | 1 | | 2013 TLVs and BEIs with 7th | 311 | Solid | | 2 | 3 | 3 H302 H317 H400 H410 |
| Tetraethylpyrofosfaat | | 0,005 | DFG 2013, Mitteilung 49 | 301 | Solid | | 4 | 4 | 4 H310 H300 H400 |
| Tetraethylthiopyrofosfaat | 0,1 | | SEG-SUM 069 | 111 | Solid/Liquid | | 4 | 4 | 4 H310 H300 H400 H410 |
| Demeton-O | | 0,01 | Gr 2000/15OSH068 | 201 | Liquid | | 4 | 4 | 4 H310 H300 H400 |
| Demeton-S | | 0,01 | Gr 2000/15OSH068 | 201 | Liquid | | 4 | 4 | 4 H310 H300 |
| Demeton-S-methyl | 0,01 | | Gr 2000/15OSH072 | 201 | Solid/Liquid | | 3 | 3 | 3 H311 H301 H411 |
| Demeton-S-methyl | 0,05 | | 2013 TLVs and BEIs with 7th | 311 | Solid/Liquid | | 3 | 3 | 3 H311 H301 H411 |
| Foraat | 0,02 | | Gr 2000/15OSH075 | 201 | Liquid | | 4 | 4 | 4 H310 H300 H400 H410 |
| Foraat | 0,05 | | 2013 TLVs and BEIs with 7th | 311 | Liquid | | 4 | 4 | 4 H310 H300 H400 H410 |
| Parathion | 0,1 | | DFG 2013, Mitteilung 49 | 301 | Liquid | | 4 | 4 | 4 H330 H300 H311 H372** H400 H410 |
| Parathionmethyl | 0,02 | | 2013 TLVs and BEIs with 7th | 311 | Solid | | 4 | 4 | 4 H226 H330 H300 H311 H373** H400 H410 |
| Ethyl-p-nitrofenylthiobenzee | 0,5 | | DFG 2013, Mitteilung 49 | 301 | Solid | | 4 | 4 | 4 H310 H300 H400 H410 |
| Coumaphos | 0,05 | | 2013 TLVs and BEIs with 7th | 311 | Solid | | 4 | 4 | 4 H300 H312 H400 H410 |
| Azinfos-methyl | 0,2 | | DFG 2013, Mitteilung 49 | 301 | Solid | | 4 | 4 | 4 H330 H300 H311 H317 H400 H410 |
| Diazinon | 0,1 | | DFG 2013, Mitteilung 49 | 301 | Solid/Liquid | | 2 | 2 | 2 H302 H400 H410 |
| Malathion | 15 | | DFG 2013, Mitteilung 49 | 301 | Liquid | | 2 | 3 | 3 H302 H317 H400 H410 |
| Ethion | 0,05 | | 2013 TLVs and BEIs with 7th | 311 | Liquid | | 3 | 3 | 3 H301 H312 H400 H410 |

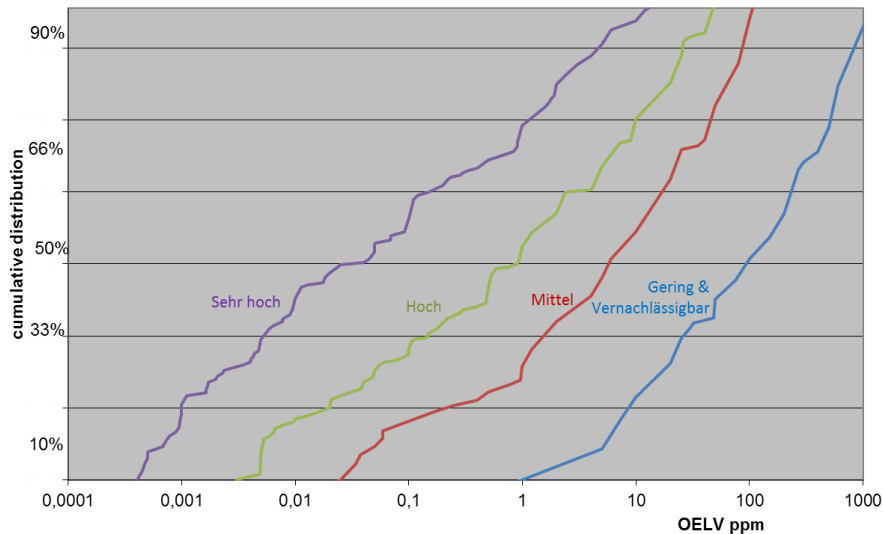
The most comprehensive database of OEL's and measurement methods

Results hazard grouping OELV distributions

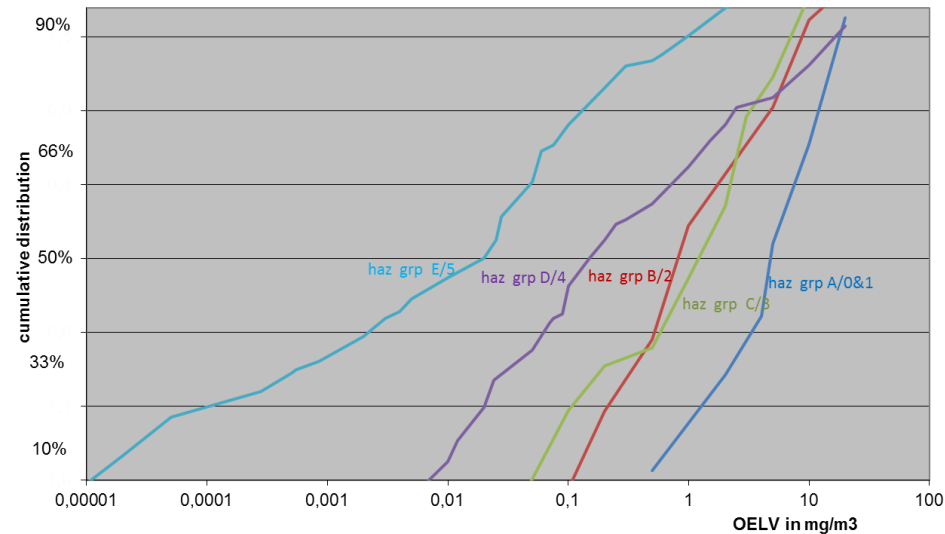
Per hazard group and physical state the OELV distribution is constructed
 Next slides:

- COSHH Essentials HSE
- EMKG einfaches Maßnahmenkonzept Gefahrstoffe BAuA
- IFA-spaltenmodell/TRG600 DGU

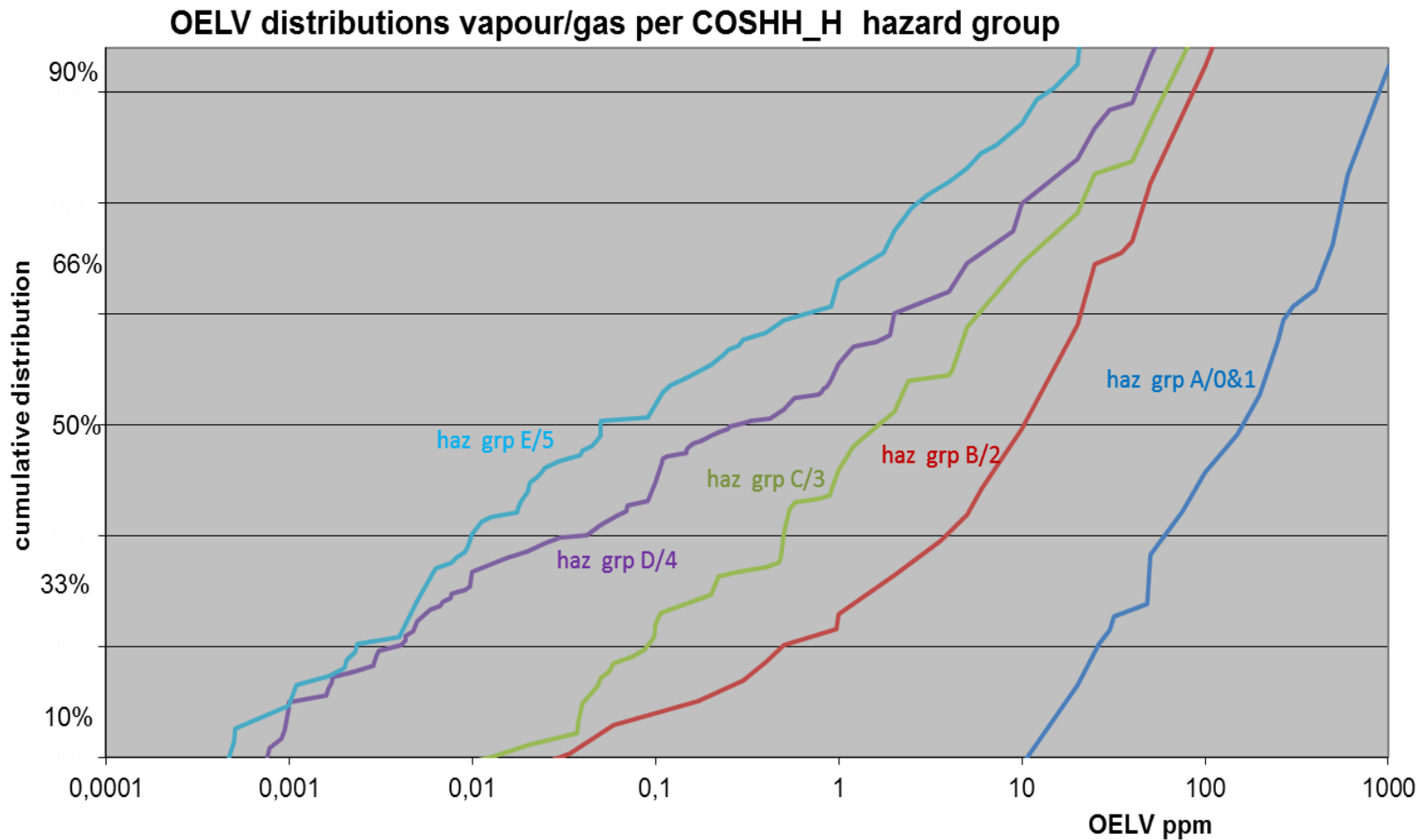
OELV distributions gas/vapour per IFA-TRGS6_H hazard group



OELV distributions dust/aerosol per COSHH_H hazard group

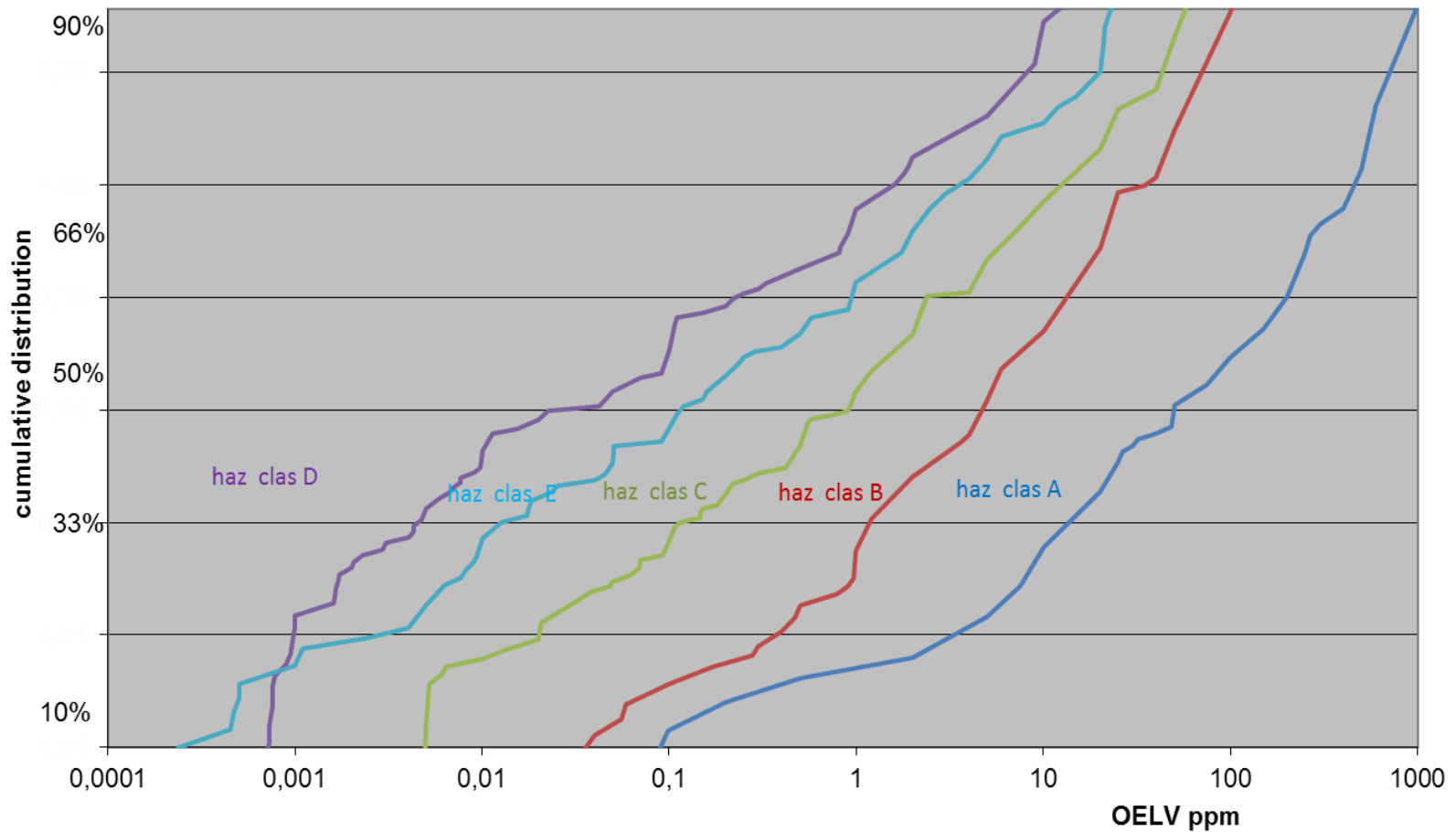


Results – COSHH vapour/gas



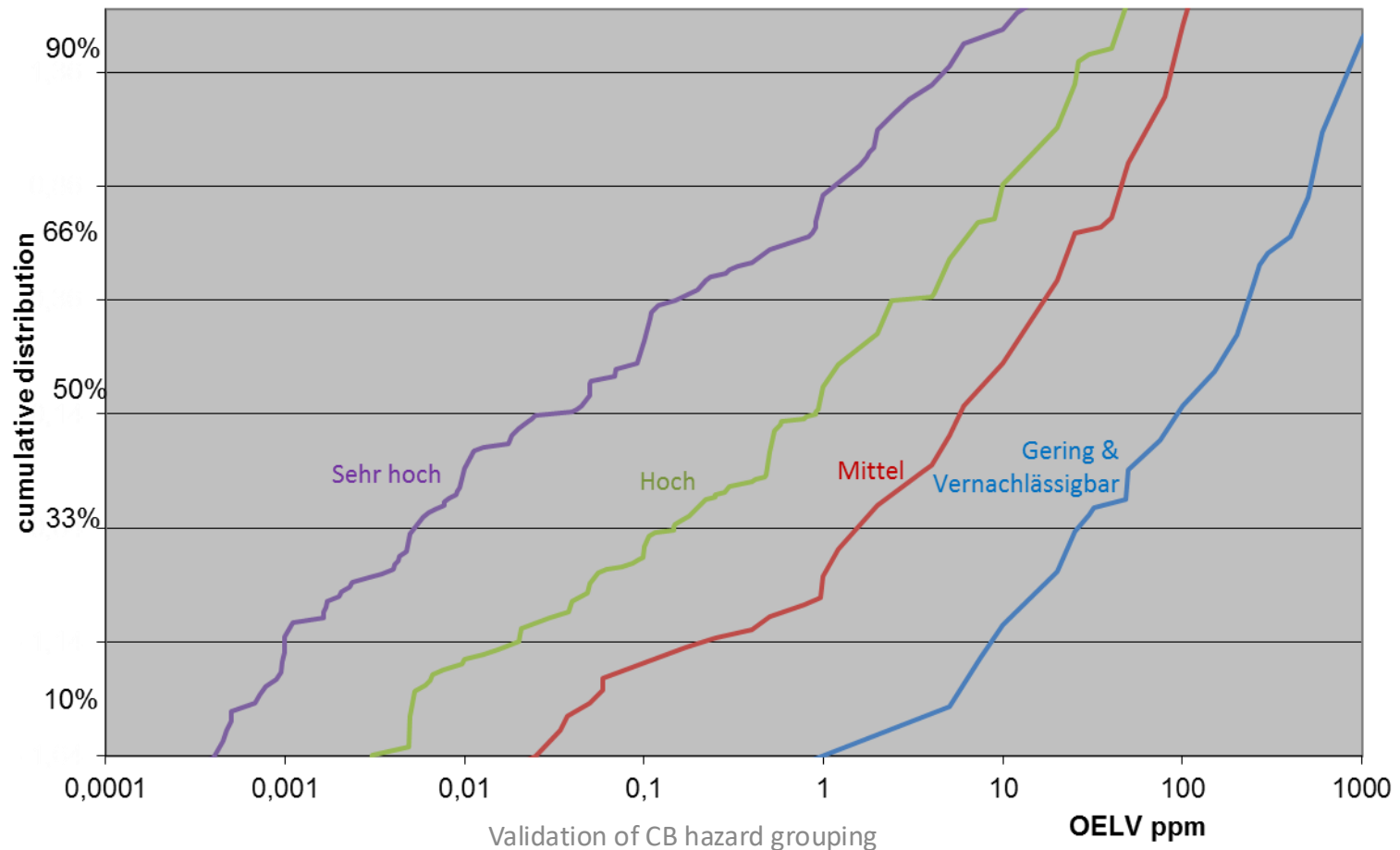
Results – EMKG (inhalation) vapour/gas

OELV distributions vapours per EMKG-HOI grouped hazard classification



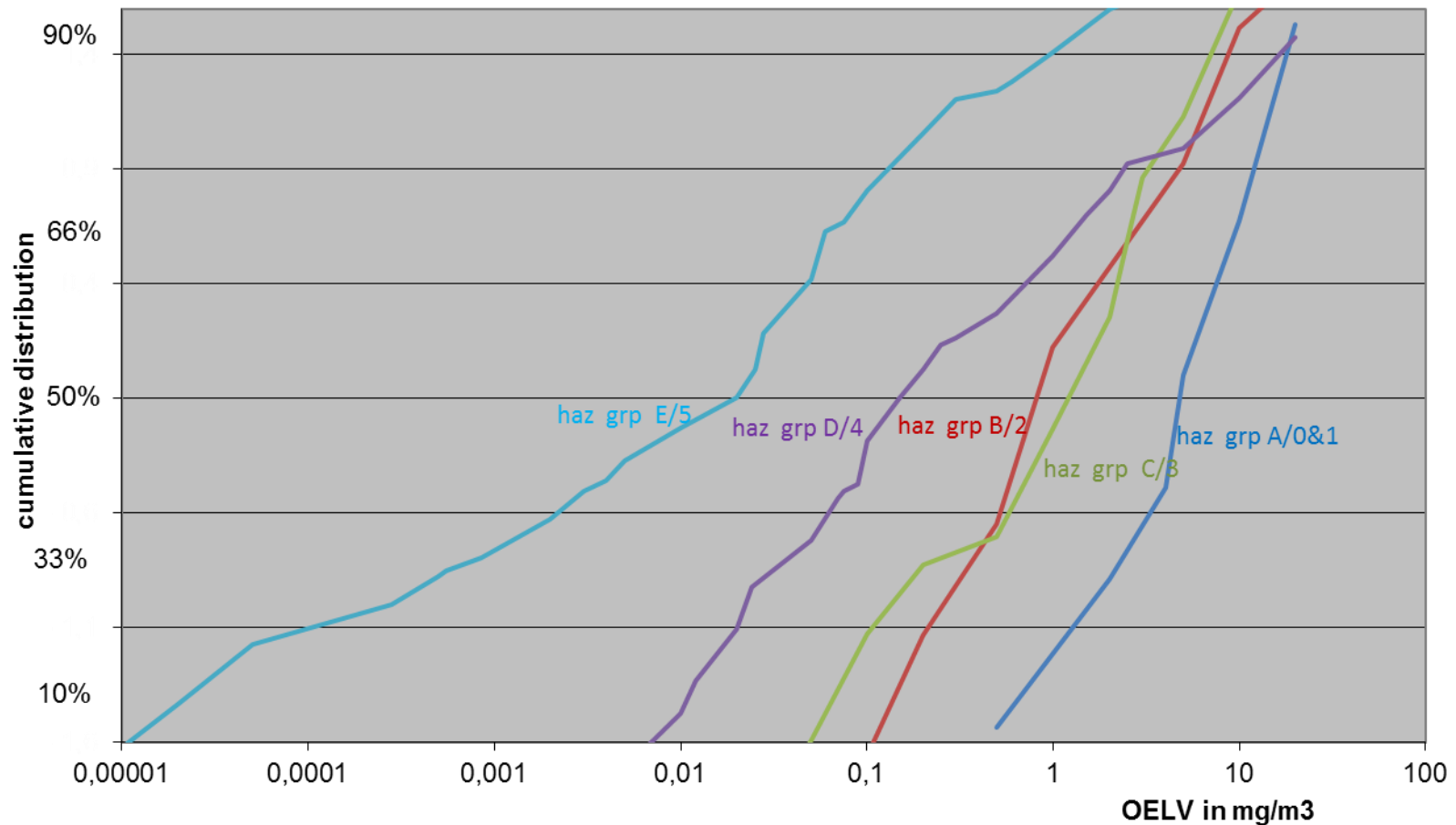
Results – IFA/TRGS600 vapour/gas

OELV distributions gas/vapour per IFA-TRGS6_H hazard group



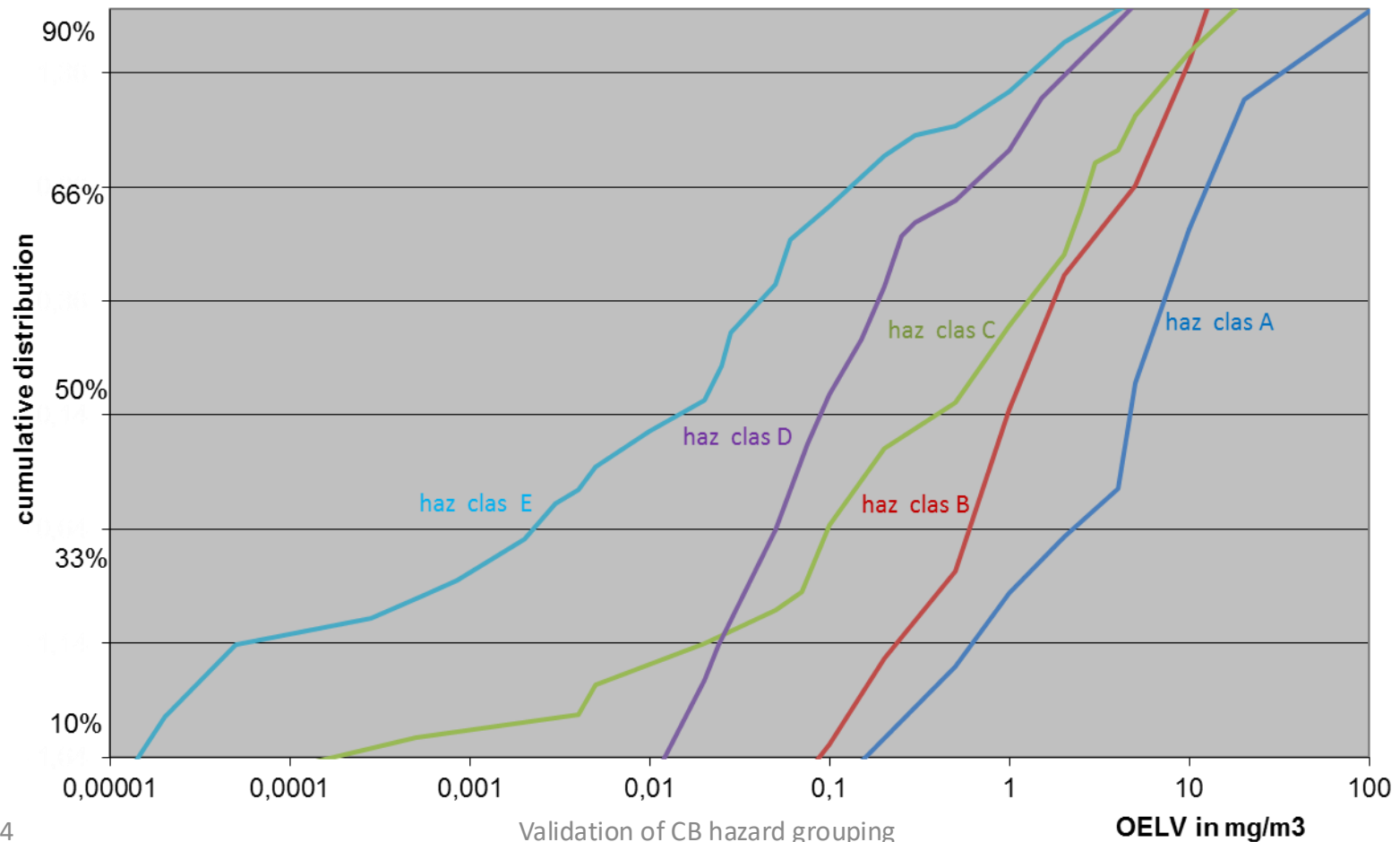
Results – COSHH dust/aerosol

OELV distributions dust/aerosol per COSHH_H hazard group



Results – EMKG (inhalation) dust/aerosol

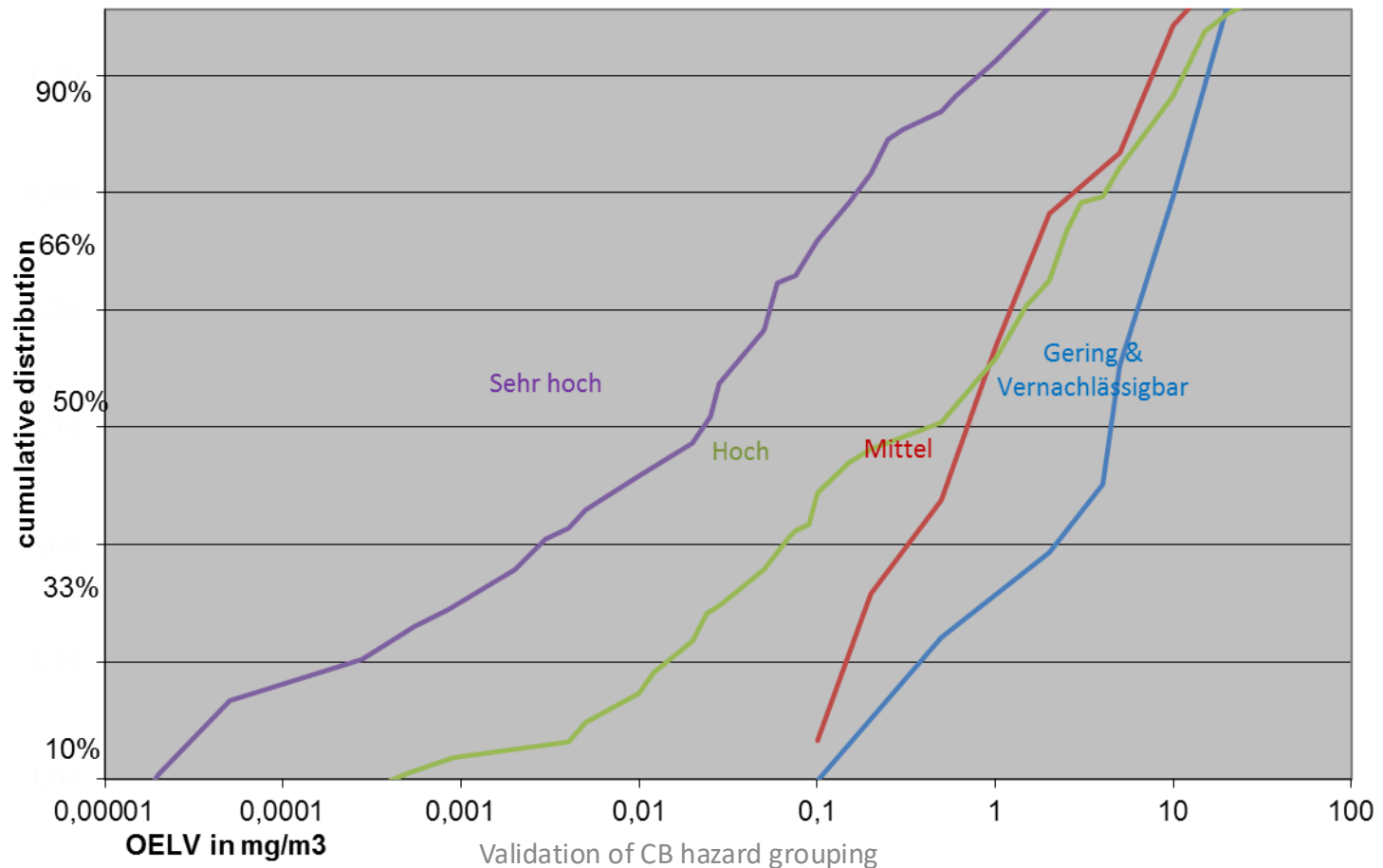
OELV distributions solids per EMKG-HOI grouped hazard classification



The most comprehensive database of OEL's and measurement methods

Results – IFA/TRGS600 dust/aerosol

OELV distributions solids per IFA-TRGS6_H hazard group

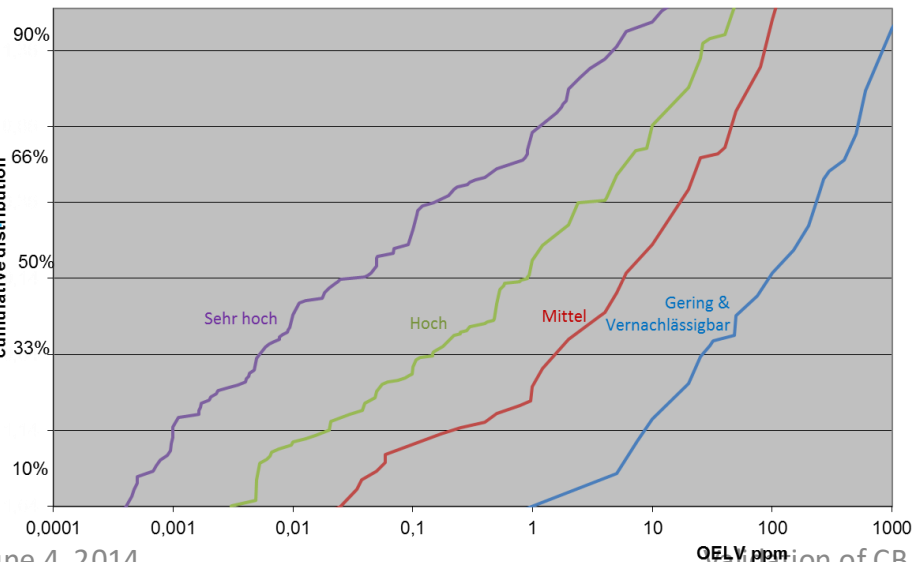


Results hazard group OELV distributions

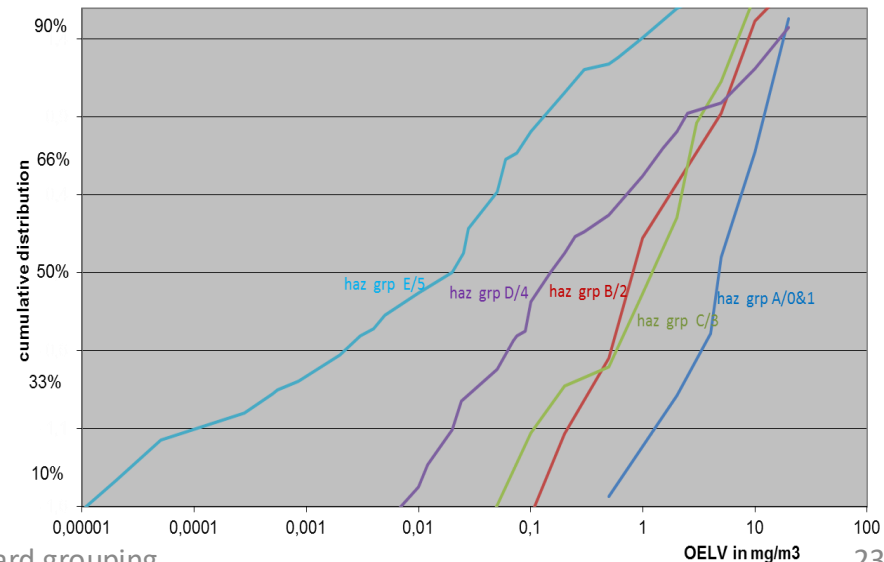
Observationally the OELV distribution strongly indicates that hazard grouping is an ordered measure but that the CB Schemes differ in power

The most comprehensive database of OEL's and measurement methods

OELV distributions gas/vapour per IFA-TRGS6_H hazard group



OELV distributions dust/aerosol per COSHH_H hazard group



OELV, statistical inference

| Physical state -> | VAPOUR/GAS | | | DUST/AEROSOL | | |
|---|-----------------------|-------|-------|--------------|-------|---------|
| | Institution/parameter | COSHH | EMKG | IFA | COSHH | EMKG |
| P(Kruskal-Wallis) | 8E-47 | 8E-45 | 4E-56 | 3E-27 | 6E-19 | 2,1E-22 |
| Fraction variance explained by grouping | 0,33 | 0,29 | 0,40 | 0,35 | 0,27 | 0,25 |
| P(log, regression coefficient <> 0) | 3E-54 | 1E-47 | 1E-70 | 2E-27 | 4E-24 | 2,1E-20 |

The best OELV-hazard group performances:

- IFA-spaltenmodell/TRG600 for vapour/gas
- COSHH Essentials for dust/aerosol

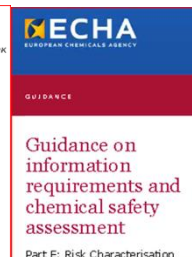
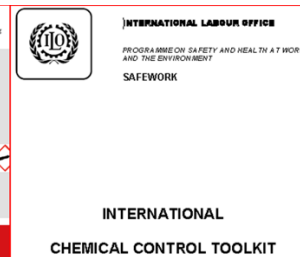


Conclusions on hazard grouping

Hazard grouping in CB schemes is an ordered measure:

- observationally it explains part of OELV dispersion
- it lacks uniformity between institutions (the whole CB system depends on it !)
- Working condition control depends on it !

Despite the short comings, hazard grouping and OELV are strongly related, **making it suitable to establish kick-off levels (earlier presentation)**

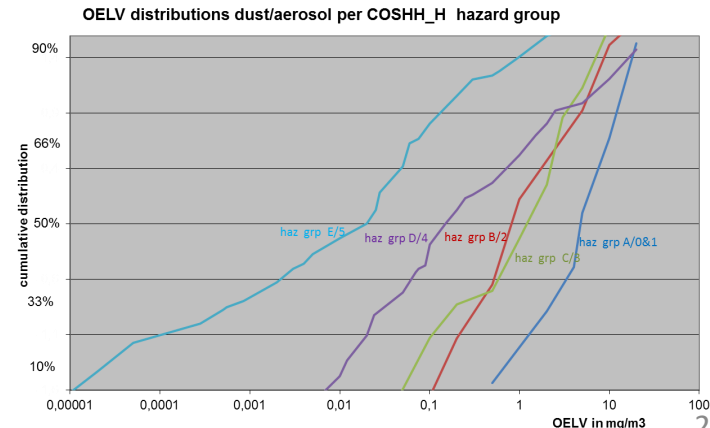
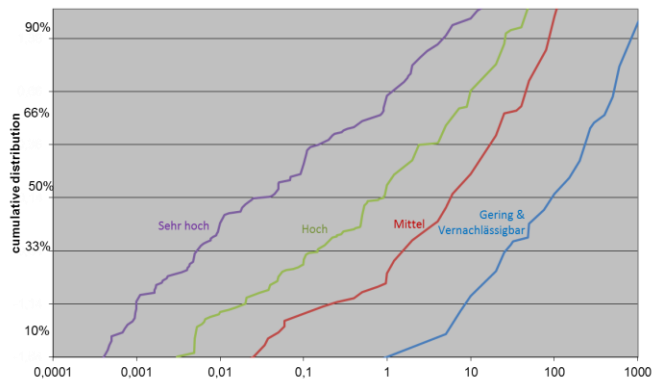


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| TRGS 600 Page - 1 - | | |
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Recommendations

To really fulfil the claim of helping SME's with a simple tool:

- Develop and use **one** universal Control Banding scheme
- Optimize hazard grouping of H-statement by minimizing OELV dispersion (GSD), maximizing OELV location (GM) differences and optimizing Lognormal goodness-of-fit



Validation of CB hazard grouping



Vapor/gas



HSE
Health and Safety
Executive

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Dust/aerosol

Thank you!

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