Comparing one In-Company “OEB” with three public Hazard Bandings

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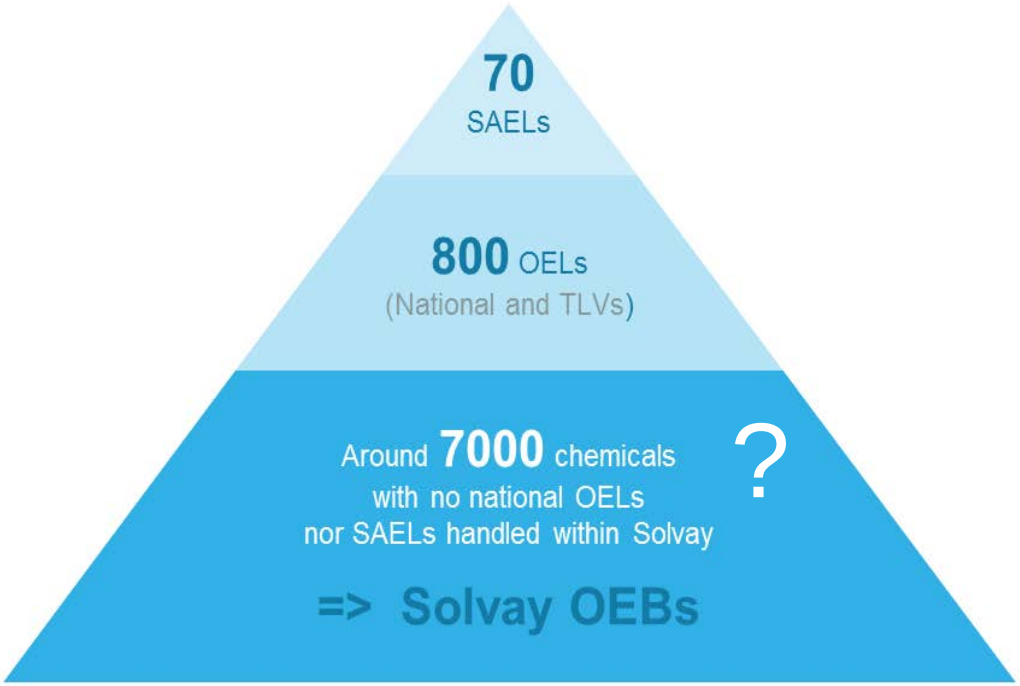
Context:

Need for appropriate risk control strategies for substances handled worldwide in the company, with no OELs neither internal SAELs[1]



[1] *Solvay Acceptable Exposure Limit*

Context:

Four different Hazard Bands HB system based on CLP/GHS H phrases:

- **IFA** (German DGUV- Spaltenmodell, 2011)
- **COSHH** (UK HSE-Control of Substances Hazardous to Health, 1999)
- **EMKG** (Inhalation module of the German BAUA, 2009)
- **S-OEB** (In-house-developed Occupational Exposure Band, Solvay OEB 2014)

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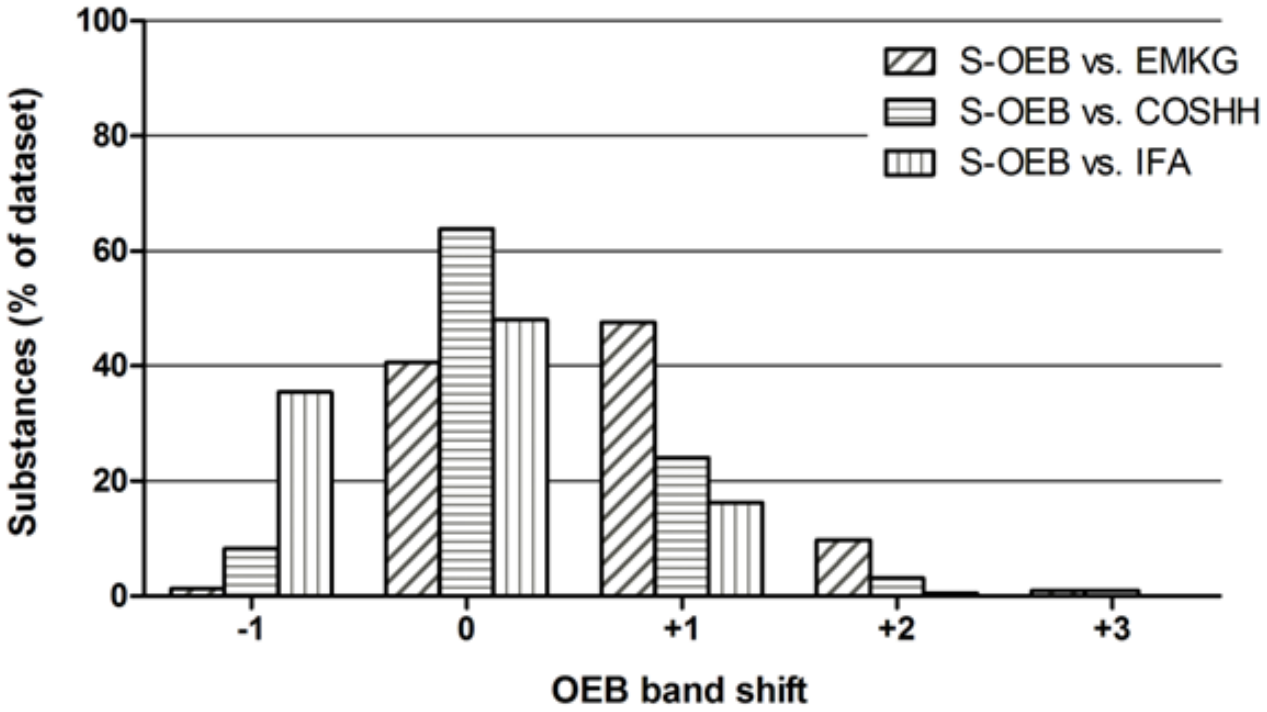
Different Hazard Band allocations

Hazard band	DGUV IFA Spaltenmodell	HSE COSHH	BAUA EMKG (inhalation)*	Solvay OEB
E/5	300, 310, 330 (Tox) 340, 350, 350i (CM) EU032 (Tox gas release)	340, 341, 350(i) (CM) 334 (S) EU070 (Tox)	340, 350, 350i (CM) 360_F (R)	372 (Tox) 340, 350 (CM) 334 (ICS)
D/4	301, 311, 331, 370, 372 (Tox) 341, 351, 360_{xy} (CMR) EUH029, EUH031 (Tox gas release) 317, 334, 318, EUH070 (ICS)	300, 310, 330, 372 (Tox) 351, 360_{xy}, 361, 362 (CR)	300, 330, 372 (Tox) 360_D (R) EUH032 (Tox gas release)	300, 310, 330; 370, 373 (Tox) 314 (+ cat A), EUH071 (ICS), 341, 351, 360_{xy} (CMR)
C/3	302, 312, 332(Tox) 314 (pH ≥ 11,5, pH ≤ 2), 371, EUH071 $361_{f/d}$, 373, 362 non-toxic gases which may cause asphyxiation	301, 311, 331, 314, 370, 373 (Tox) 317, 318 , 335, EUH071 (IC)	301, 331, 314, 370, 371, 373 (Tox) 334 (S) 341, 351, 361f/d (CMR) EUH031 (Tox gas release)	301, 311, 331; 371 (Tox) 304, EUH070 (lung, eye damage) 314 cat B and C, 317, 318, 335 (ICS) 361, 362 (R & Lact)
B/2	315, 319, 335, ** (I) 304, EUH066, 336 (solvents) ***	302, 312, 332, 371 (Tox)	302, 332 (Tox) 318 (C)	302, 312, 332, 336 (Tox) 315, 319, EUH066 (I)
A/1	substances which experience shows to be harmless (e.g. water, sugar, paraffin etc.)	303, 313, 333(GHS Tox4) 315, 316, (GHS) 319, 320 (I) 304, 305 (Aspiration) 336 , EUH066 (solvents) and all H-numbers not otherwise listed	319, 335 (I) 336 (solvent) 304 (Aspiration) Non health hazard H-statement codes	303, 313, 333 (GHS Tox 4) 305 (ICS) 316 (GHS-> noCLP), 320 (GHS eye irr 2b->CLP 319)

Methods

- A 229 substances dataset from Company's portfolio built containing the GHS/CLP classifications and OELs.
- Only "golden standard" OELs selected (SCOEL, TLV, DNEL-workers, and internal SAEL)
- Comparing, among HB systems:
  1. Difference in Hazard Band allocations
  2. Strength of differentiation relative to the actual OEL
  3. Validity of the associated airborne concentration ranges, relative to the OELs

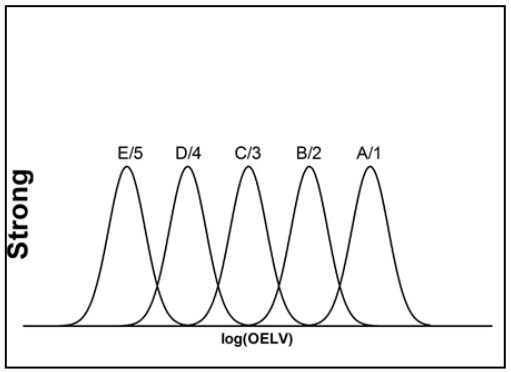
Results:
Difference in Hazard Band allocations

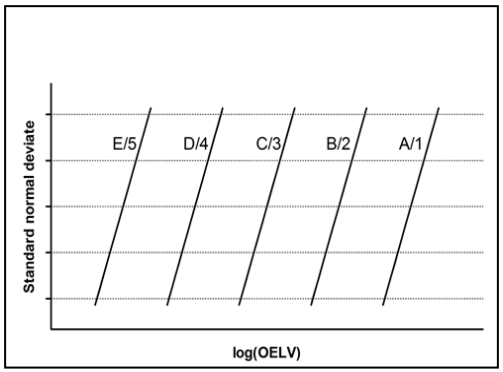


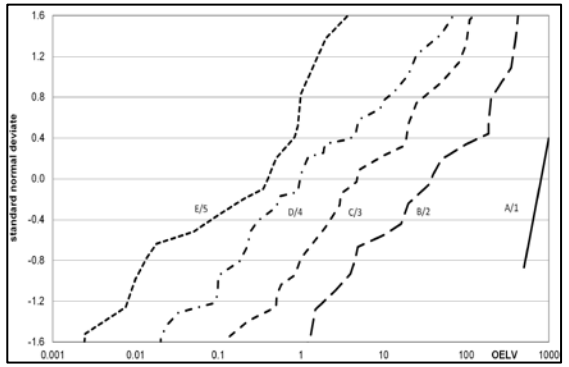
Relative to S-OEB, the 3 HB systems assign equal bands for at least 40% of the substances.
The remaining substances differ at least on one band, with IFA placing more substances in a higher band and EMKG doing the opposite.

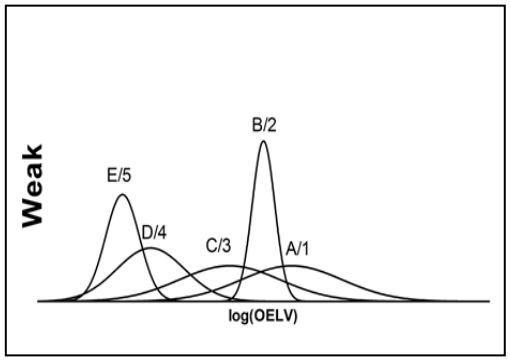
Results:
Strength of differentiation relative to the actual OEL

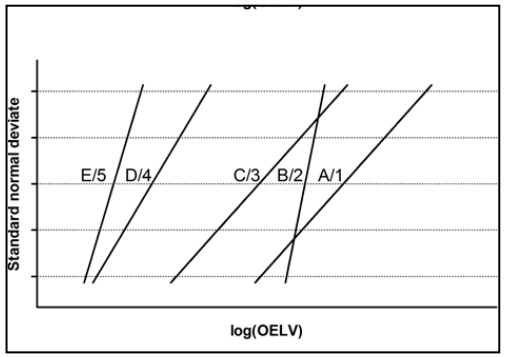
Log-normal distribution	Cumulative log-normalized probability plot	Cumulative log-normalized probability plot
Theory	*Theory*	*Actual*

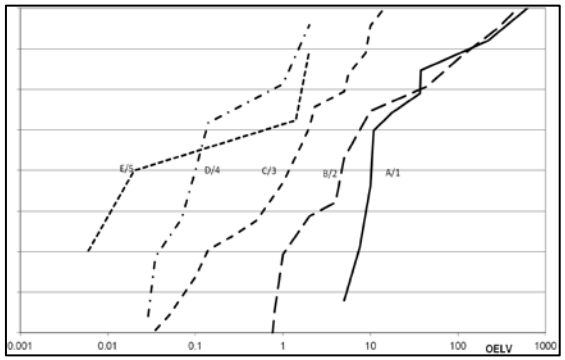












Results:

Strength of differentiation relative to the actual OEL

HB-System	p(S-W) of the residuals	Percentage of overall log(OELV) variability explained by hazard banding	Homogeneity of log(OELV) variance within the hazard bands (p(Levene))	Equidistant log(OELV) means. P(Non-Linear contrast.)	Number of pairwise independent log(OELV) means ($p < 0.05$) #	Overall Strength Score
Vapour/gas (n=158)						
S-OEB	3 (52.6%)	3 (38%)	2 (18.7%)	4 (72.2 %)	4 (4 out of 4)	**16**
COSHH	1 (4.02%)	1 (25%)	1 (4.3%)	2 (53.5 %)	1 (1 out of 4)	**6**
EMKG	4 (90.9%)	4 (41%)	3 (28.1%)	1 (5.5 %)	2 (2 out of 4)	**14**
IFA	2 (12.9%)	2 (36%)	4 (33.8%)	3 (70.1 %)	3 (3 out of 4)	**14**
Dust/aerosol (n=71)						
S-OEB	1 (0.3%)	4 (50%)	4 (79.3%)	2 (7.8 %)	3 (2 out of 3)	**14**
COSHH	2 (2.5%)	2 (41%)	2 (16%)	3 (17.4 %)	1 (1 out of 3)	**10**
EMKG	3 (2.9%)	3 (49%)	1 (12.7%)	4 (64.0 %)	3 (2 out of 3)	**14**
IFA	4 (4.2%)	1 (38%)	3 (42.7%)	1 (0.7 %)	3 (2 out of 3)	**12**

S-OEB relates at least as strong to OEL as the other HB systems

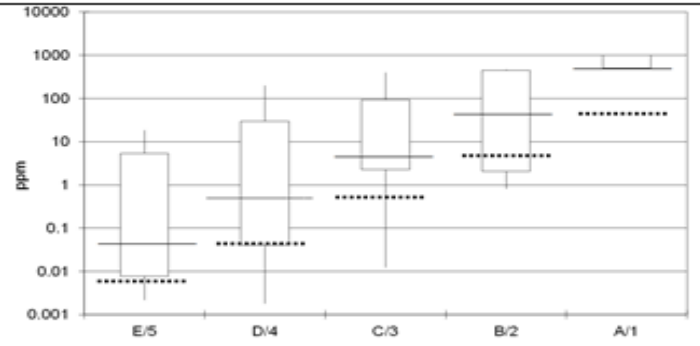
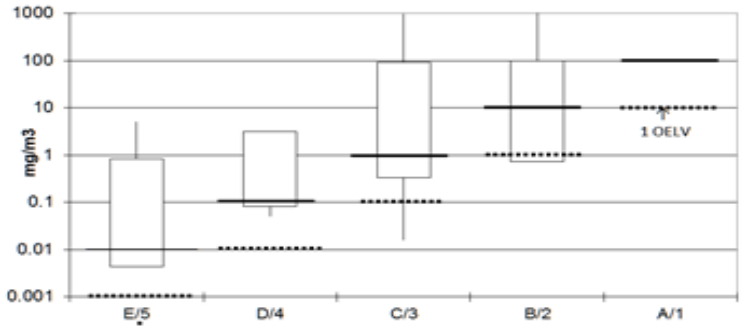
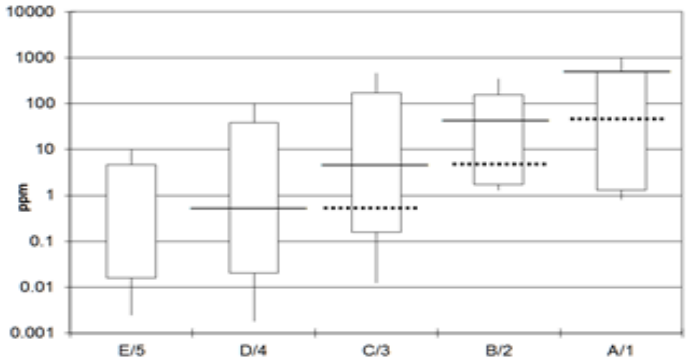
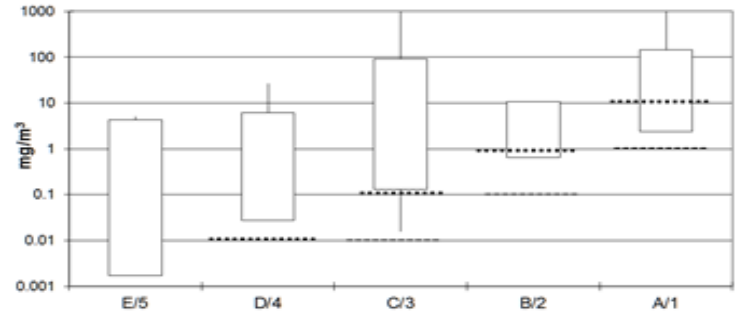
Results:

Validity of the associated airborne concentration ranges (2 HB systems only)

Hazard Band	S-OEB concentration range		COSHH concentration range	
	vapour/gas (ppm)	dust/aerosol (mg/m^3)	vapour/gas (ppm)	dust/aerosol (mg/m^3)
E/5	0.005-0,05	0.001-0.01	Not established, consult a specialist	
D/4	0.05-0,5	0.01-0.1	<0.5	<0.01
C3	0.5-5	0,1-1	0.5-5	0.01-0.1
B/2	5-50	1-10	5-50	0.1-1
A/1	50-500	10	50-500	1-10

Results:

Validity of the associated airborne concentration ranges

	Vapour/gas: upper end _____ lower end.....	Dust/aerosol upper end _____ lower end .....
S-OEB		
COSHH		

The concentration ranges of the 3 highest bands are best covered by their S-OEB related OEL distributions

Conclusions:

- The method was able to discriminate and rank HB-engines.
- Our investigations confirmed S-OEB's applicability as a standard within Solvay's global operations.
- This approach should be extended for further developments and alignment of WW HB systems.

Thanks !

BOHS
The Chartered Society for Worker Health Protection

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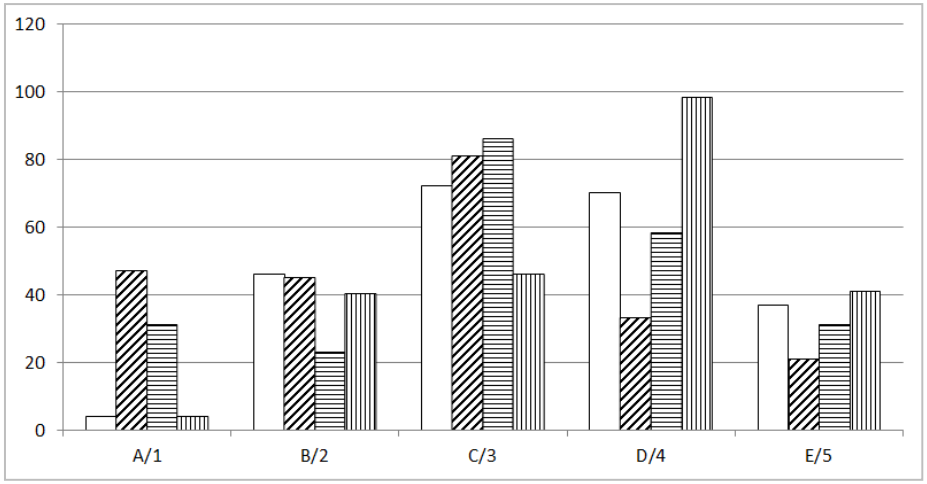
Back up:

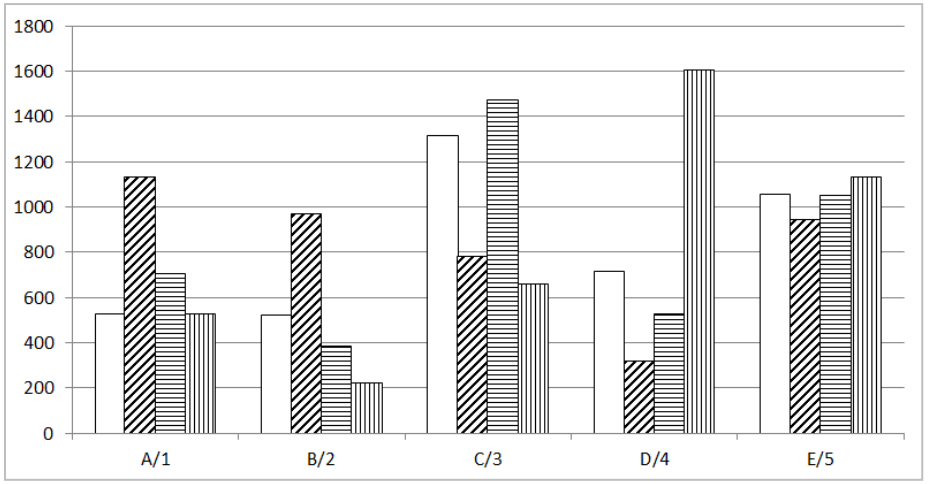
- Representativeness of 229 selected chemicals in term of frequencies per hazard band

Frequencies per hazard band

Selected 229 substances data set



Full 4140 ATP5 CLH substances



S-OEB EMKG COSHH IFA

No major bias of under representation of each one of the hazard band in the 229 substance data set.