SDM 2.0

Supporting Risk Evaluations under TSCA Using the Structured Deterministic Model

Susan Arnold, PhD, CIH arnol353@umn.edu

Mark Stenzel, MS, CIH
Daniel Drolet, MS
Puleng Moshele, PhD Candidate

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EPA’s Role in OH&S under TSCA

To systematically evaluate chemical risks across the lifecycle of the product, including the entire value chain

- Pure chemicals
- Chemical mixtures

- Regulate those deemed to present unreasonable risks

Implementation Challenges

- Limited availability and representativeness of exposure data
- Focus on worst-case scenarios that compound conservative assumptions
- IH practitioners focused on task-based assessment; regulatory scientists focused on lifetime (cumulative) risk
- Differences in how impact of engineering controls, PPE considered
- Communicating risks and guidance in alignment with other disciplines, regulations

MaryAnn Hoff and Silvia Maberti

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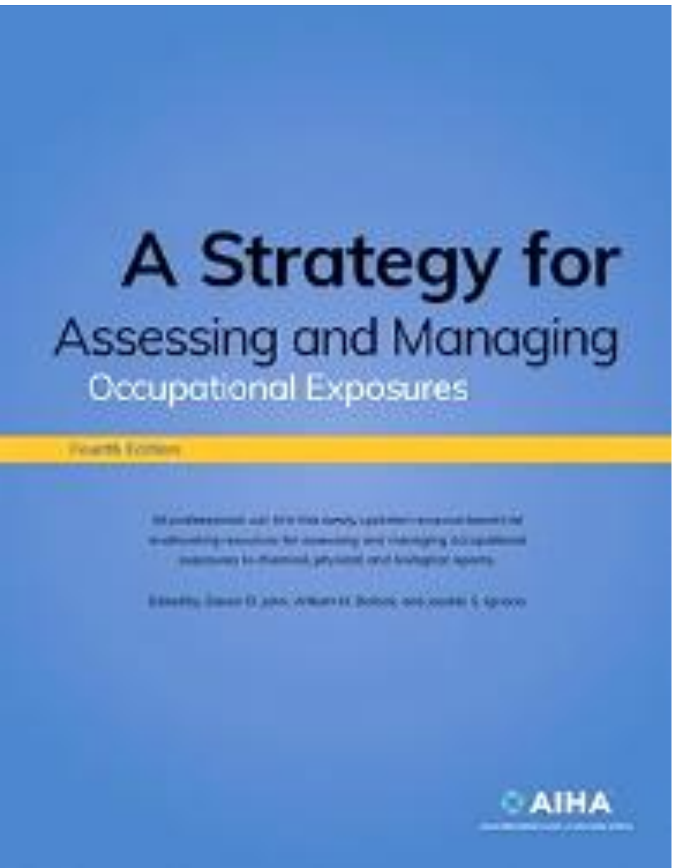
Opportunities for Practitioners and Regulatory Scientists

- Strategically leverage representative exposure data (where available) with model output from IHEST, SDM 2.0, IHMod 2.0, etc. to assess real-world conditions across a range of scenarios, through Bayesian analysis
- Leverage professional judgment
- Use tools like SDM 2.0 to construct work histories, incorporating task-based exposures to develop cumulative exposure profiles
- Communicate risk for practical risk management (categorical) and regulatory assessment (quantitative)

What is Professional Judgment?

"The application and appropriate use of knowledge gained from the formal education, exeprience, experimentation, inference, and analogy. The capacity of an experienced professional to draw correct inferences from incomplete quantitative data, frequently on the basis of observations, analogy and intuition."



Bullock. W.H. and Ignacio, J.S: (editors) *A Strategy for Assessing and Managing Occupational Exposures* Third Edition. Fairfax, VA: American Industrial Hygiene Association (2006)

Need for Professional Judgment

- Professional judgment plays a critical role in any field in which decisions must be made in the absence of a complete data set
- In real world situations, we will never have a complete data set…

Inputs

- Intuition
- Experience
- Literature
- Algorithms, Checklists and Models
- Robust Data Set

Professional Judgment - Approaches

Subjective methods → for decision making range from less transparent intuitive approaches to more disciplined and systematic approaches

Objective methods → derived from careful reviews of available information about

- exposure agents
- data related to the workforce, jobs, materials, work practices, engineering controls and protective equipment.
- supplemented with worker interviews, review of the technical basis for exposure limits, and when available, personal monitoring data.

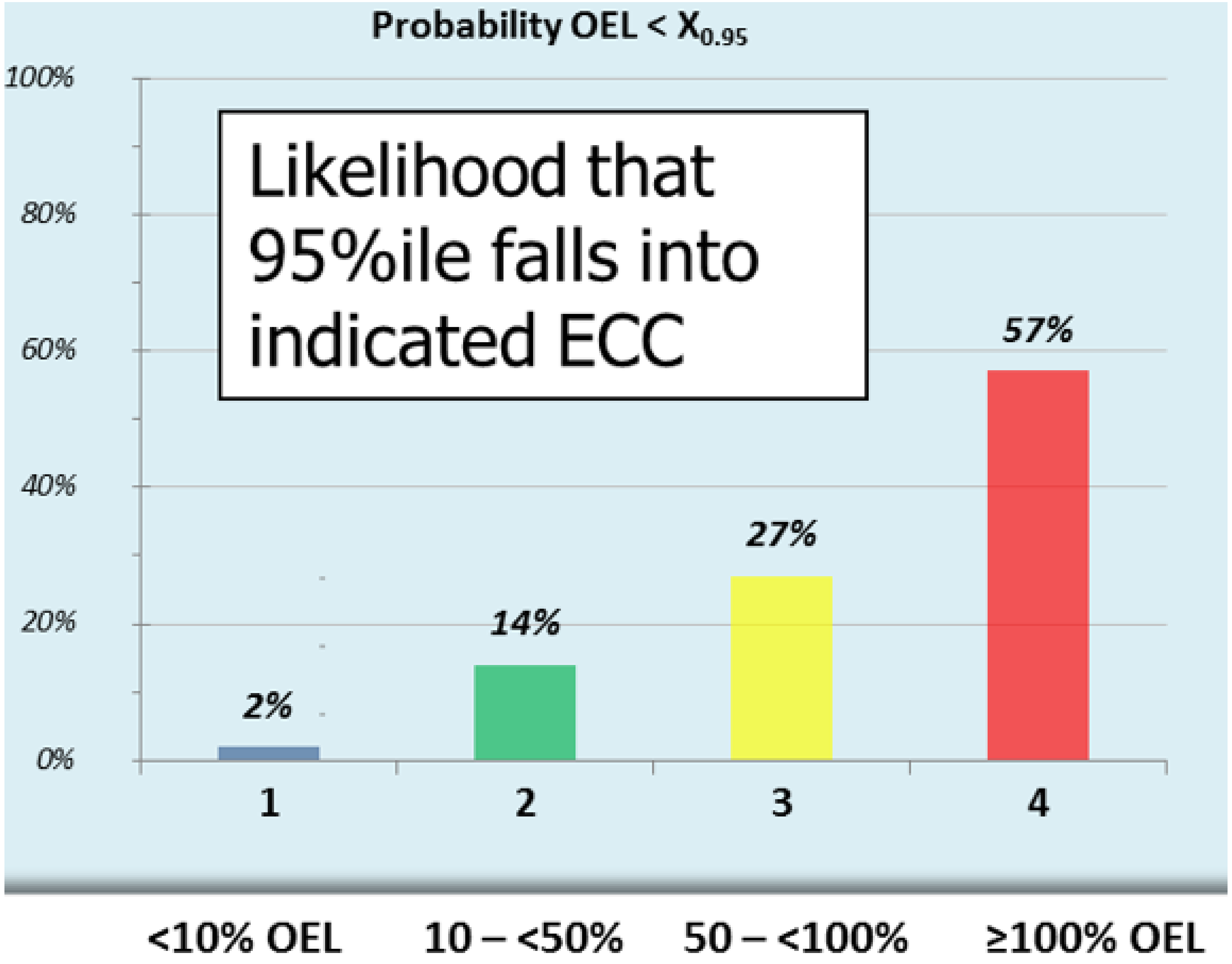
(Arnold et al., 2015)

Expressing Exposure Judgments Using

Exposure

Control

Categories



Expanded ECC framework – Checklist 1

SEG Exposure Control Category	Relationship to the OEL (95th Percentile)	Respirator Assigned Protection Factors
0	$X_{0.95} \leq 0.01$ x Exposure Limit (OEL)	
1	0.01 x OEL < $X_{0.95} \leq$ 0.1 x OEL	
2	0.1 x OEL < $X_{0.95} \leq$ 0.25 x OEL	
2,5	0.25 x OEL < $X_{0.95} \leq$ 0.5 x OEL	
3	0.5 x OEL < $X_{0.95} \leq$ 1.0 x OEL	
4	1.0 x OEL < $X_{0.95} \leq$ 2.0 x OEL	APF-10
5	2.0 x OEL < $X_{0.95} \leq$ 5.0 x OEL	APF-10
6	5.0 x OEL < $X_{0.95} \leq$ 10.0 x OEL	APF-10
7	10.0 x OEL < $X_{0.95} \leq$ 25.0 x OEL	APF-25
8	25.0 x OEL < $X_{0.95} \leq$ 50.0 x OEL	APF-50
9	$X_{0.95} \leq$ 50.0 x OEL	APF- >50

In SDM2.0 category 4 is expanded to provide more granularity when the OEL is exceeded

Exposure Intensity Categories – Checklist 1

Future SDM 2.0 functionality

to support health-based studies,

cumulative risk assessment, etc.

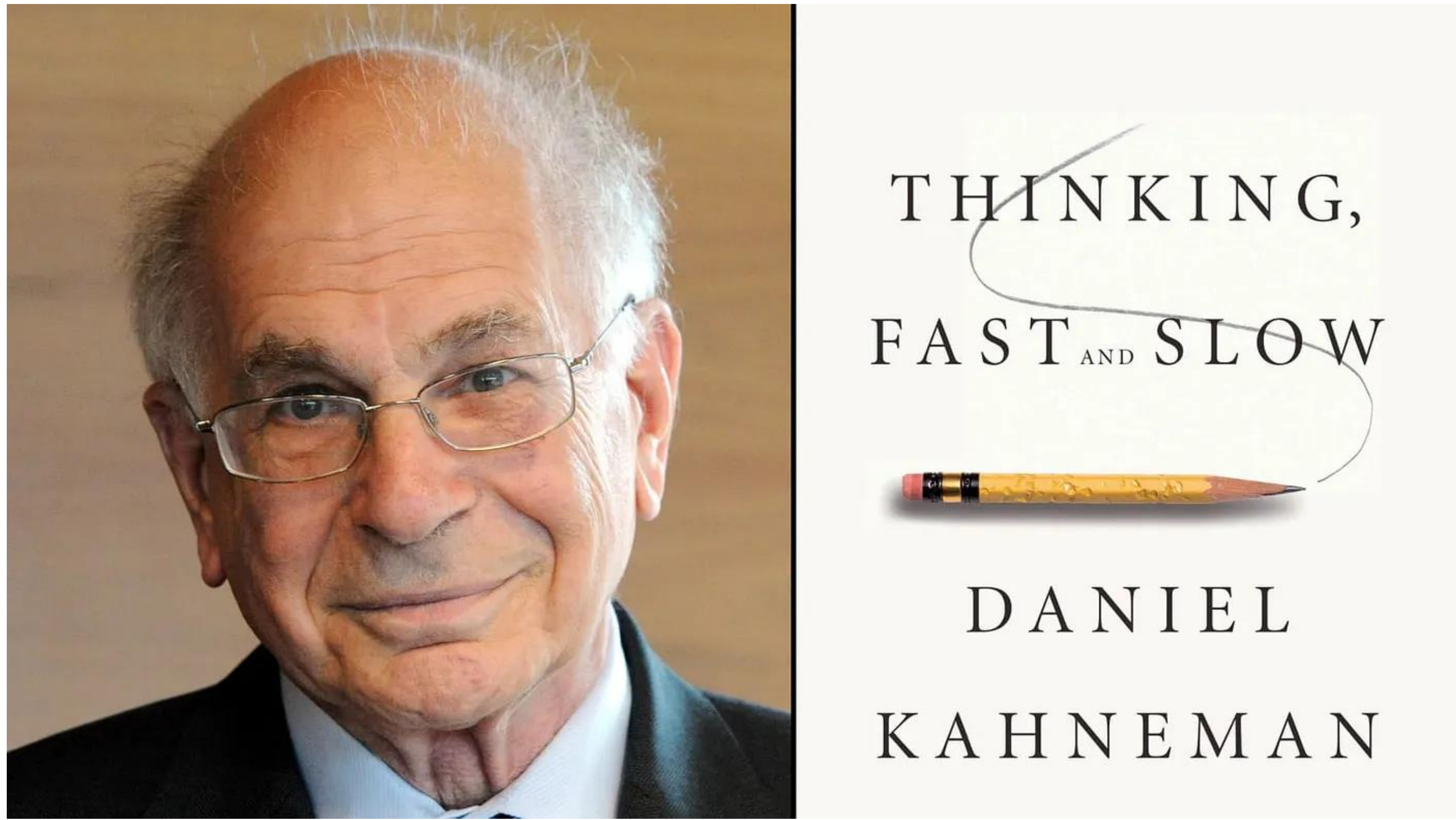
Exposure Intensity Category	Exposure Metric Range (ppm, ppb, or μg/m^3, ppm-years, etc.)
0	<0.003
1	≥0.003 and <0.01
2	≥0.01 and <0.03
3	≥0.03 and <0.1
4	≥0.1 and <0.3
5	≥0.3 and <1.0
6	≥1.0 and <3.0
7	≥3.0 and <10.0
8	≥10.0 and <30.0
9	≥30.0

Role and Value of Intuition

"Intuition can be a useful tool aiding in accurate decision making if, and only if it is followed by the *disciplined collection of objective information* with disciplined scoring and analysis of that information

In other words, "intuitive judgments can be useful when delivered by well-calibrated, experienced professionals operating within their domain of expertise "

Kahneman, 2011



Low Judgment Accuracy

- Research has shown subjective qualitative exposure judgments tend to be no more accurate than random chance, with a significant underestimation bias

- i.e., **marked tendency to assign a lower exposure category than the correct one**, thus increasing occupational risk to workers

Logan et al. 2009; Vadali et al., 2012; Arnold et al., 2015

Effectiveness and Efficiency of Decision-Making Strategies

Effectiveness → the ability to reach a correct decision;

Efficiency → the ability of an exposure assessment strategy to reach a decision with a minimum or tolerable expenditure of resources;

GOAL

a high probability of detecting a clearly unacceptable group exposure profile.

Limited Power of Small Sample Sizes

Exposure Scenario:

OEL = 10 ppm

GSD = 2.5

EF	GM	95^{th} % ppm	Distribution <OEL
0.50	10.0	45.15	0.500
0.25	5.39	24.32	0.750
0.10	3.09	13.95	0.900
0.05	2.22	10.00	0.950

EF = Exceedance Fraction GM = Geometric Mean 95th % = 95^{th} Percentile GSD = Geometric Standard Deviation

Limited Power of Small Sample Sizes

Percentage of Time that All Measurements of Dataset Size N (N=1, 2, 3, 4, or 5) Will Fall Below the OEL

Exposure Scenario:

OEL = 10 ppm

GSD = 2.5

EF	GM	95th % ppm	Distribution <OEL	1
0.50	10.0	45.15	0.500	50.0
0.25	5.39	24.32	0.750	75.0
0.10	3.09	13.95	0.900	90.0
0.05	2.22	10.00	0.950	95.0

EF = Exceedance Fraction GM = Geometric Mean 95th % = 95th Percentile GSD = Geometric Standard Deviation

Limited Power of Small Sample Sizes

Exposure Scenario:

OEL = 10 ppm

GSD = 2.5

Percentage of Time that All Measurements of Dataset Size N (N=1, 2, 3, 4, or 5) Will Fall Below the OEL

EF	GM	95^{th} % ppm	Distribution <OEL	1	2
0.50	10.0	45.15	0.500	50.0	25.0
0.25	5.39	24.32	0.750	75.0	56.3
0.10	3.09	13.95	0.900	90.0	81.0
0.05	2.22	10.00	0.950	95.0	90.3

EF = Exceedance Fraction GM = Geometric Mean 95th % = 95^{th} Percentile GSD = Geometric Standard Deviation

Limited Power of Small Sample Sizes

Exposure Scenario:

OEL = 10 ppm

GSD = 2.5

Percentage of Time that All Measurements of Dataset Size N (N=1, 2, 3, 4, or 5) Will Fall Below the OEL

EF	GM	95^{th} % ppm	Distribution <OEL	1	2	3	4	5
0.50	10.0	45.15	0.500	50.0	25.0	12.5	6.25	3.13
0.25	5.39	24.32	0.750	75.0	56.3	42.2	31.6	23.7
0.10	3.09	13.95	0.900	90.0	81.0	72.9	65.6	59.1
0.05	2.22	10.00	0.950	95.0	90.3	85.7	81.5	77.4

EF = Exceedance Fraction GM = Geometric Mean 95th % = 95^{th} Percentile GSD = Geometric Standard Deviation

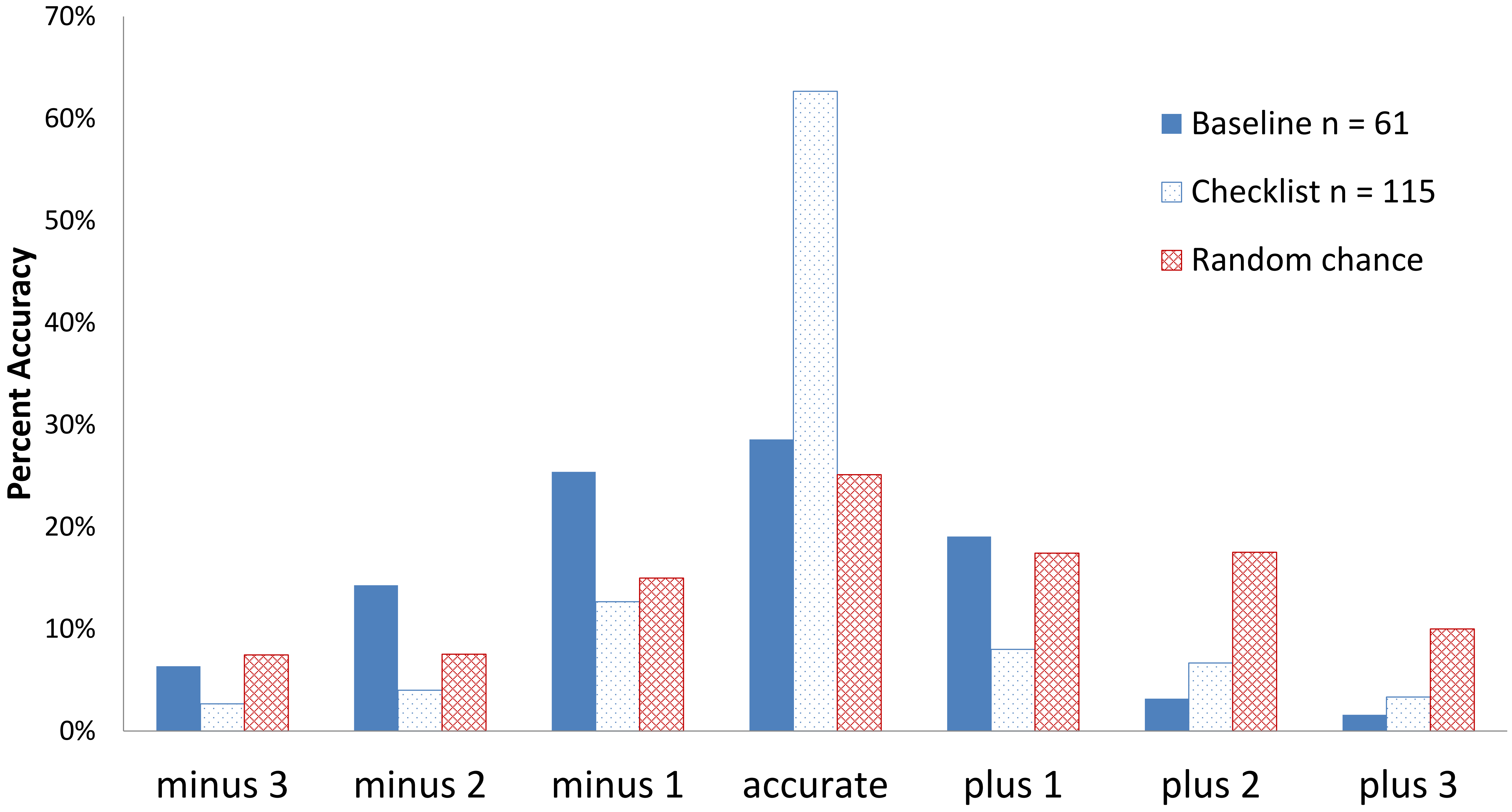
A case study in professional judgment and decision making

Boeing Model 299
"The Flying Fortress"

The Structured Deterministic Model (SDM 2.0)

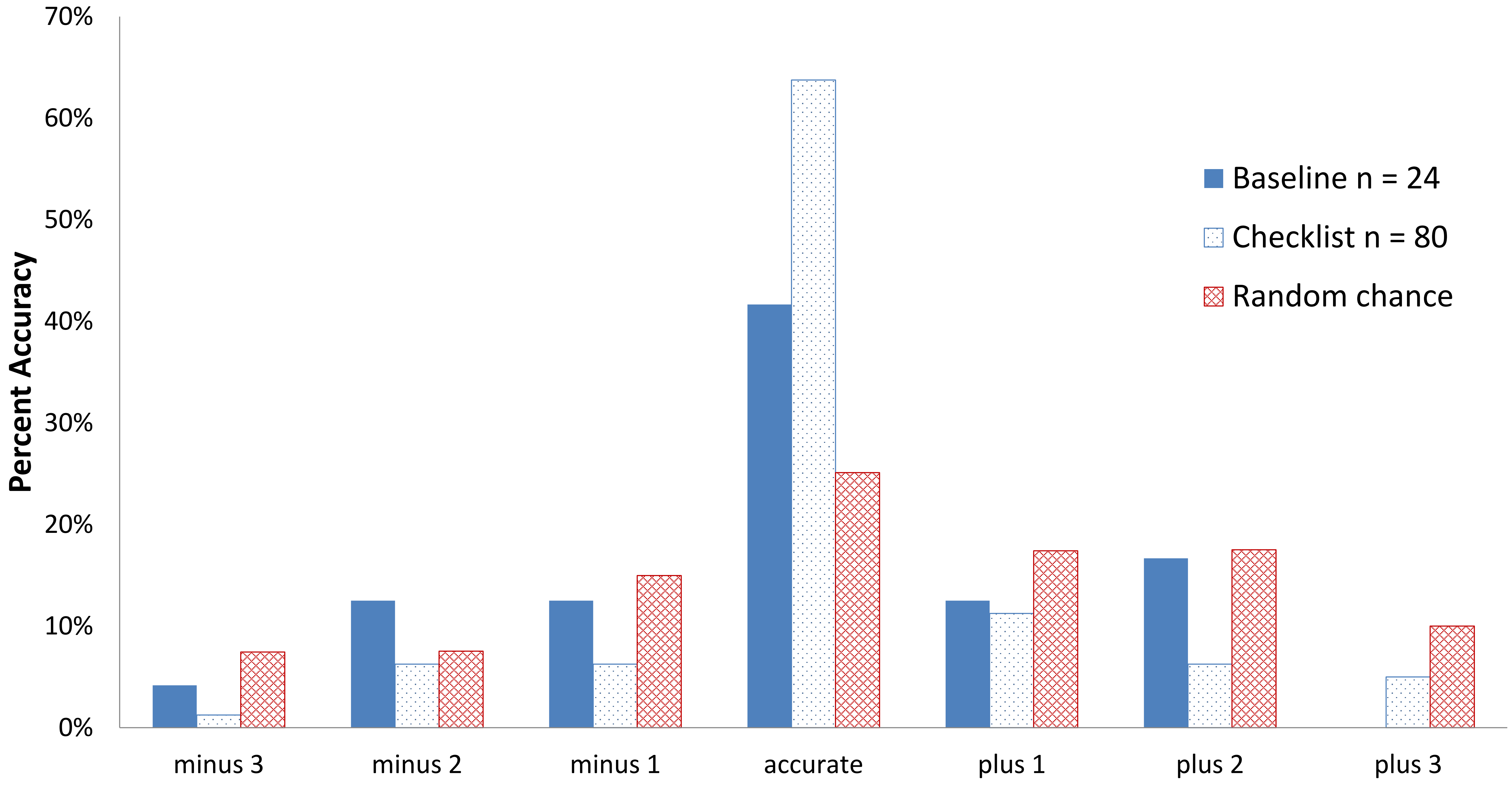
- Structured, like a checklist to ensure consistent application, every time
- Applying simple algorithms or heuristics to improve judgment accuracy
- Algorithms based on physical-chemical principles, developed empirically, refined through experience over many years

Post-Checklist Training Accuracy, Practicing OHs



Arnold SF, Stenzel M, Drolet D, et al. *Using checklists and algorithms to improve qualitative exposure judgment accuracy*. J Occup Environ Hyg 2016; 13: 159-168. DOI: 10.1080/15459624.2015.1053892.

Post-Checklist Training Accuracy, Novice OHs



Arnold SF, Stenzel M, Drolet D, et al. *Using checklists and algorithms to improve qualitative exposure judgment accuracy*.
J Occup Environ Hyg 2016; 13: 159-168. DOI: 10.1080/15459624.2015.1053892.

Structured Deterministic Model 2.0

University of Minnesota
Driven to Discover®

ESSI Exposure Science and Sustainability Institute

SDM 2.0
Structured Deterministic Model

AIHA Exposure Assessment Strategies COMMITTEE

Introduction

Zoom
768p
1080p
1440p
2160p

This tool is a deterministic model that provides point estimates of the 95th percentile airborne concentrations as a predictor of inhalation exposure to chemicals. It applies to pure, or relatively pure, volatile and semi-volatile chemicals and chemical mixtures (Checklist #1), and fibers, particulates and aerosols (Checklist #2). Raoult's Law and Henry's Law have been added to support the assessment of chemical mixtures.
A significantly expanded Exposure Control Category framework, Health Effects Rating, and Frequency and Duration scales have been incorporated to inform risk management decisions and priority setting when exposures are likely to exceed the Occupational Exposure Limit.

SDM 2.0 is not appropriate for assessing scenarios involving thermal decomposition, polymers or chemicals under pressure.

Premium Version

Checklist #1
for assessing exposure to pure chemicals or chemical mixtures comprised of volatile and semi-volatile agents.

Checklist #2
for assessing exposure to particulates, fibers and aerosols

Disclaimer

Before using

Credits

Read the Support File documentation, and be sure you understand how this tool works. Your judgments, and any tool that informs your judgment should be calibrated using exposure measurement data.

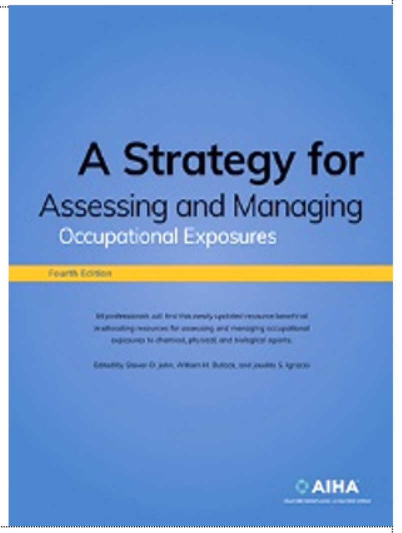
Comments

Link

More information about the algorithms can be found in the Support File, and in the AIHA Publication and in the following publications:

Jahn, S.D., William H. Bullock, Joselito S. Ignacio: *A Strategy for Assessing and Managing Occupational Exposures.* AIHA Press, 2015, Chapters 6, 23, 26.

Puleng Moshele, Mark R. Stenzel, Daniel Drolet, Susan F. Arnold. (2024) *Comparing Antoine Parameter Sources for Accurate Vapor Pressure Prediction Across a Range of Temperatures*. Annals of Work Exposures and Health. Apr 22; 2024; 68(4):409-419



Version 2,02 : January 2026

Conception: Susan F. Arnold, Mark Stenzel, Puleng Moshele and Daniel Drolet

Arnold S.F, Stenzel M. R., Mushele P. and D. Drolet, (2022).
SDM 2.0. Structured Deterministic Model. (Version 2,0)
Software available from University of Minnesota and AIHA.org

Key Determinants and Algorithms

Governed by three critical determinants of exposure that are incorporated into four key algorithms

SDM 2.0
Structured Deterministic Model

- Vapor pressure of the chemical or chemical component,
- Occupational Exposure Limit
- Level of control

Four Main Algorithms

Vapor Hazard Ratio

Rule of Ten

Frequency and Duration

} Checklist 1

Particulate Hazard Ratio — Checklist 2

Vapor Hazard Ratio

Measure of a chemical's potential to exceed its OEL.

$$\text{VHR} = \frac{VP\ (mm\ of\ Hg)}{OEL\ (ppm)}$$

VHR Table : Identifying Required Level of Control

Vapor Hazard Ratio Scale	Vapor Hazard Ratio (VHR)	Required Levels of Control
1	< 0.05	General Ventilation (GV) ~ 3 to 6 air turnovers /hr.
2	0.05 to < 1	Good General Ventilation (GGV) ~ 6 to 12 air turnovers/hr.
3	1 to < 25	GGV with Capture - Local Exhaust Ventilation (LEV) at emission points
4	25 to < 500	Capture - LEV at points of emission with containment wherever practical
5	500 to < 3000	Containment - Worker is positioned outside the enclosure, the source of vapor is located inside the encloser and there is adequate net air flow to inhibit vapors' migration out of the enclosure.
6	> 3000	Primary and Secondary Containment

Examples of VHR Applications

- Introduction of a new chemical into existing process
- Change process chemicals
- Batch processing using same equipment
- Campaign operations (weeks or months)
  – use same equipment to produce multiple products
- Distribution of various types of fuels of varying composition.

Rule of 10 (ROT)

- Based on chemical principles that evolved through empirical observations of exposure scenarios where quantitative measurements were available.

- Outcome of applying the rule is **a point estimate of the 95th Percentile** based on a fraction of the saturated vapor concentration dictated by the level of control.

1. Rule of 10

$$Saturation\ (SVC) = \frac{Vapor\ Pressure\ (VP)\ (mm\ Hg)}{760\ mm\ Hg\ \ X\ 1\ 000\ 000}$$

Fraction of the saturation vapor concentration "SVC"	Fraction of SVC	Example
Very Limited	1/10th	Confined space with no mechanical ventilation (<1ACH)
Poor	1/100th	Confined space with limited ventilation (1-3 ACH)
Good General Ventilation Indoors – Displaced air	1/300th	Indoor work with ~ 3-6 ACH, where displaced air occurs
Good General Ventilation Indoors / Outside – displaced air	1/1000th	Indoor work areas with 3-6 ACH, e.g., manufacturing work setting
Good General Ventilation – Indoors with high ACH	1/3000th	Indoor work areas with 6-12 ACH, auxiliary fans to augment GGV
Good General Ventilation - Outside	1/3000th	Outdoors where the wind is at least 1-2 mph/2–3 km/h)
Capture Local Exhaust Ventilation	1/10000th	Mechanical ventilation configured to capture vapor release at the source
Containment Local Exhaust Ventilation	1/100000th	Source is contained in enclosed hood with sufficient face velocity to prevent vapor escape

Examples of Applications of ROT

- Compare exposures to the OEL to determine compliance status and the exposure control categories (ECCs).
- Link to the chemical's **h**ealth **e**ffects **r**ating (**HER**) to establish a **h**ealth **r**isk **r**anking (**HRR**).
- Link task-based exposure to frequency and duration
- Trigger decisions, actions, priority setting, feasibility analysis, levels of communication, etc.

Chemical Mixtures

Assume the following mixture

Chemical	Weight %
Toluene	40
Xylene	20
Ethyl acetate	20
Benzene	2
Methylene chloride	3
Carbon tetrachloride	15

Controlling **C**omponent

Which component is controlling?

That is, in a mixture, which component has the highest potential to exceed its corresponding OEL?

SDM 2.0 Mixtures Output

ESSI Exposure Science and Sustainability Institute | SDM 2.0 | *Gas and Vapors* | ***REPORT*** | *Quantitative Ordinal Task Exposure Assessment Too*

Scenario parameters

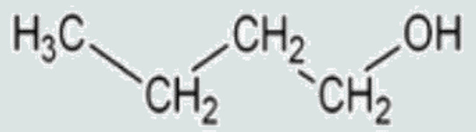
									Concentration (ppm)							ECC						
	Chemical	CAS #	Wt	OEL ppm	VP mm Hg	Adj. VP	Adj. VHR	VHR Ratio %	Very Limited	Poor	GGV inside – displaced air	GGV inside / GGV outside – displaced air	GGV outside	GGV + LEV –capture	GGV + LEV -enclosing hoods	ECC Very Limited	ECC Poor	ECC GGV inside – displaced a	ECC GGV inside / GGV outs	ECC Good - Outside	ECC GGV + LEV –capture	ECC GGV + LEV -enclosing h
1	toluene	108-88-3	40	20	28.4	12.230	0.612	12.7	1610	161	53.6	16.1	5.36	1.61	0.16	9	6	5	3	2	1	0
2	xylene	1330-20-7	20	100	8.74	1.632	0.016	0.339	215	21.5	7.16	2.15	0.72	0.22	0.02	5	2	1	1	0	0	0
3	ethyl acetate	141-78-6	20	400	93.2	20.980	0.052	1.09	2760	276	92	27.6	9.2	2.76	0.28	6	3	2	1	1	0	0
4	benzene	71-43-2	2	0.5	94.8	2.407	4.814	100	317	31.7	10.6	3.17	1.06	0.32	0.03	9	9	7	6	5	3	1
5	methylene chloride	75-09-2	3	25	435	15.240	0.610	12.7	2000	200	66.8	20	6.68	2	0.2	9	6	5	3	2	1	0
6	carbon tetrachloride	56-23-5	15	5	115	11.180	2.236	46.4	1470	147	49	14.7	4.9	1.47	0.15	9	8	6	5	3	2	1

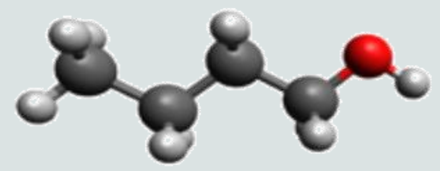
Case study: n-butyl alcohol in batch processing

Using the SDM 2.0 to account for process-related weathering

1-butanol
(n-butanol)

$CH_3\text{-}CH_2\text{-}CH_2\text{-}CH_2OH$





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n-butyl alcohol (BuOH) in Batch Processing

- A toller has a contract to produce specification grade (>99%) butyl acrylate. The toller has three 1000-gallon reactor vessels that will run simultaneously. One operator runs all three reactors over their shift. The vessels are equipped with water cooling coils to control temperatures at 25°C . The esterification reaction follows:
- n-butyl alcohol (BuOH) + acrylic acid (HACR) → butyl acrylate (BuACR) + water (H_2O)
- The reaction is run at 25°C to avoid polymerization of both acrylic acid and butyl acrylate which are heat sensitive. The reaction is run in the solvent n-hexane, which is insoluble in water.
- As water is formed in the reaction the water separates into a layer that can be decanted. The separation of the water drives the reaction to completion. The total reaction time is typically about 8 hours.
- Once the reaction is completed, the vessel's pressure is reduced to 0.1 atmosphere which results in the evaporation of the n-hexane solvent to < 0.01% in the finished product.

n-butyl alcohol (BuOH) in Batch Processing

- The hexane is recovered in a chiller. The removal of the hexane requires about one hour. The final specification grade BuACR (99.5%) contains about 0.5% residual BuOH. The excess HACR will be recovered in the water layer.
- The charging of the three reactors is staggered at about three-hour intervals resulting in each reactor being at a differ point in the reaction. The vessels are charged closed system.
- The initial composition of the charge is 26.0% HACR, 22.3% BuOH and 51.8% hexane.
- The operator collects a sample from each reactor initially and then about every two hours. The sample is collected into a 6-ounce sample bottle through a sampling valve.

n-butyl alcohol (BuOH) in Batch Processing

- We will assume good general ventilation (GGV) indoors. There is no LEV at the sampling point.
- Assume the sample collection takes 2 minutes and samples are collected from each vessel.
- At two hours the reaction is about 50% complete, at 4 hours 75% complete, at 6 hours 90% complete, and after 8 hours complete but still contains the n-hexane. It is removed after 9 hours. The attached table contains pertinent information.
- Assume that each reactor must be sampled at each time in the table.

What is the operator's BuOH exposure associated with this task?

n-butyl alcohol (BuOH) in Batch Processing

Chemical Composition over 9-hour Process:

			Time (Hr)	0	2	4	6	8	9
				% Completion					
Component	MW *g/mole*	VP *mm Hg*	OEL *ppm*	0	50%	75%	90%	100%	Solvent Removal
BuOH	74.1	7	20	22.27%	11.46%	5.81%	2.00%	0.12%	0.50%
HACR	72.1	3.97	2	26.01%	15.51%	10.07%	6.73%		
BuACR	128.2	5.45	2		19.82%	30.11%	36.45%	42.60%	99.5%
N-hexane	86.2	153	50	51.82%	53.22%	54.01%	54.47%	57.35%	

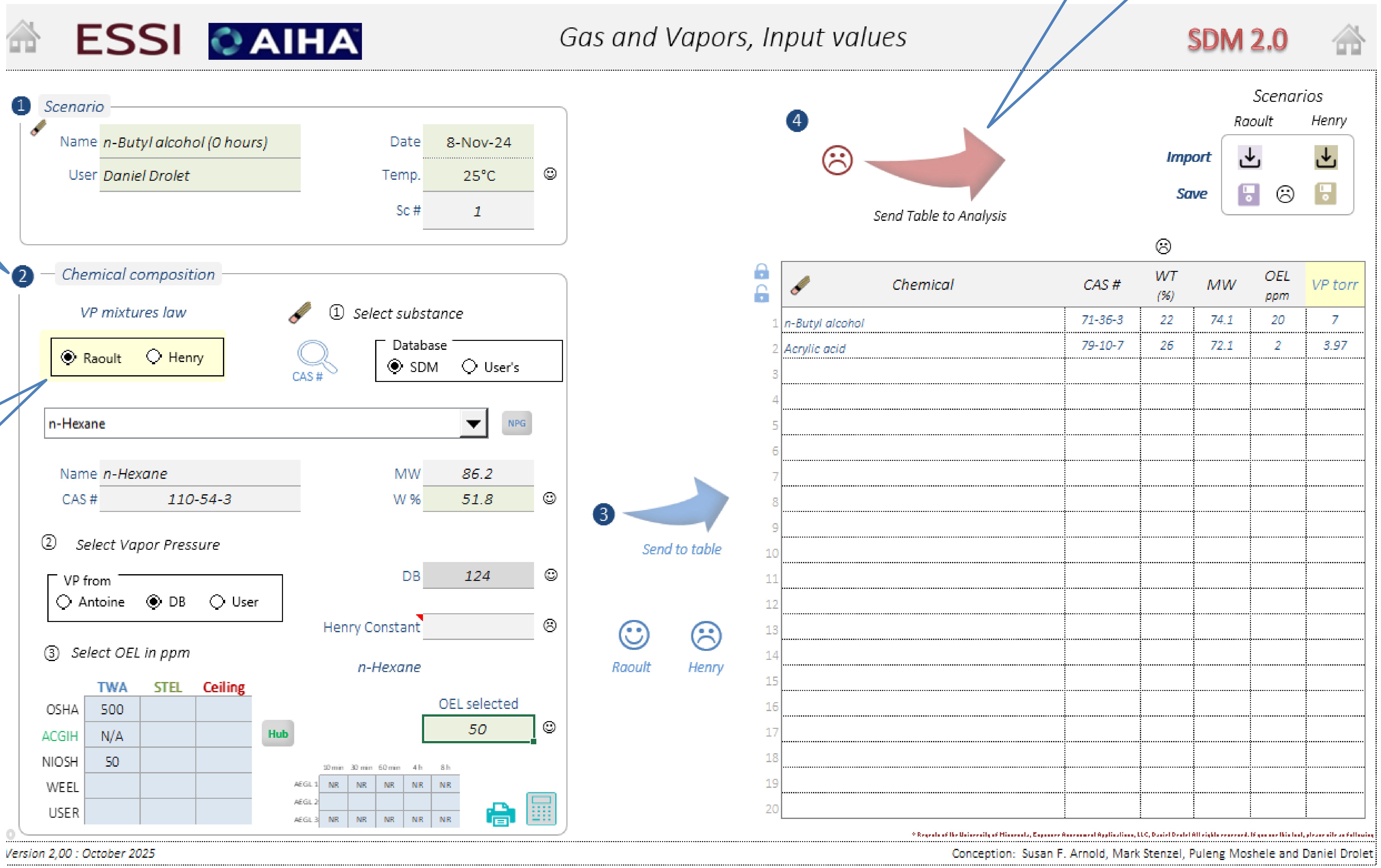
How should we begin to assess the BuOH exposures?

Building the Scenario – BuOH

Input components and transfer to Table iteratively

In this scenario, we will use Raoult's Law to estimate the VP for all components in the organic layer

When all the components have been entered, the Table can be sent for analysis



SDM2.0 output BuOH(0 hours)

ESSI Exposure Science and Sustainability Institute | SDM 2.0 | *Gas and Vapors* | ***REPORT*** | *Quantitative Ordinal Task-Bas[ed] Exposure Assessment Tool*

input

Save PDF

Scenario parameters

1 *n-Butyl alcohol (0 hours)* | Daniel Drolet | 25°C | 8-Nov-24

Mixture parameters

OEL_{mix} = 6.03 ppm or **19.7 mg/m³**

MW_{mix} = **79.848** g/mole

Adj VHR_{mix} = **2.109**

Tot. Adj VP_{mix} = **75.7** mm Hg

ECC mixture	9	9	9	7	6	4	2
HRR (matrix 4)	6	6	6	5	5	3	2

								Concentration (ppm)							ECC						
	Report RAOULT Chemical	CAS #	Wt	OEL ppm	VP mm Hg	Adj. VP	Adj. VHR	VHR Ratio %	Very Limited	Poor	GGV inside – displaced air	GGV inside / GGV outside – displaced air	GGV outside	GGV + LEV –capture	GGV + LEV -enclosing hoods	ECC Very Limited	ECC Poor	ECC GGV inside – displaced a	ECC GGV inside / GGV outs	ECC Good - Outside	ECC GGV + LEV –capture	ECC GGV + LEV -enclosing h
1	n-Butyl alcohol	71-36-3	22.2	20	7	1.663	0.083	5.7	219	21.9	7.2	2.19	0.73	0.22	0.02	7	4	2.5	2	1	1	0
2	Acrylic acid	79-10-7	26	2	3.97	1.135	0.568	38.9	149	14.9	4.98	1.49	0.5	0.15	0.01	9	6	5	3	2	1	0
3	n-Hexane	110-54-3	51.8	50	153	72.900	1.458	100	9590	959	320	95.9	32	9.59	0.96	9	7	6	4	3	2	1

Multiple vessels – BuOH batch operation

Calculate BuOH exposure for each hour for vessel 1

(based on the level of control of 'GGV inside/GGV outside – displace air)

Concentration (ppm)

Vessel 1

Time (Hr)

	0	1	2	3	4	5	6	7	8	9
BuOH	2.19	0	1.24	0	0.67	0	0.24	0	0.02	0.08
HACR	1.49	0	0.99	0	0.68	0	0.47	0	0	0
N-hexane	95.9	0	109	0	117	0	123	0	134	0
BuACR	0	0	0.97	0	1.56	0	1.97	0	2.38	7.11

Using SDM2.0 to estimate cumulative exposures

Identify exposure patterns:

Exposure at each vessel will be the same but with a time lag according to process timing

Day	Hour	Vessel 1	Vessel 2	Vessel 3		Analysis Pattern
1	0	0	8	6		1
	1	1	9	7		2
	2	2	0	8		3
	3	3	1	9		2
	4	4	2	0		4
	5	5	3	1		0
	6	6	4	2		5
	7	7	5	3		0
2	8	8	6	4		6
	9	9	7	5		2
	0	0	8	6		1
	1	1	9	7		2
	2	2	0	8		3
	3	3	1	9		2
	4	4	2	0		4
	5	5	3	1		0
3	6	6	4	2		5
	7	7	5	3		0
	8	8	6	4		6
	9	9	7	5		2
	0	0	8	6		1
	1	1	9	7		2
	2	2	0	8		3
	3	3	1	9		2
4	4	4	2	0		4
	5	5	3	1		0
	6	6	4	2		5
	7	7	5	3		0
	8	8	6	4		6
	9	9	7	5		2
	0	0	8	6		1
	1	1	9	7		2
5	2	2	0	8		3
	3	3	1	9		2
	4	4	2	0		4
	5	5	3	1		0
	6	6	4	2		5
	7	7	5	3		0
	8	8	6	4		6
	9	9	7	5		2
6	0	0	8	6		1
	1	1	9	7		2
	2	2	0	8		3

Cumulative exposure pattern repeats every 5 days

Calculating cumulative TWAs to build work histories

Day	Hour	Vessel 1	Vessel 2	Vessel 3		Analysis Pattern	Hour	Vessel 1 BuOH (ppm)	Cumulative 1 hr TWA BuOH (ppm)	Cumulative 8 hr TWA BuOH	Cumulative Weekly TWA BuOH
1	0	0	8	6		1	0	2.19	0.082	0.095	0.079
	1	1	9	7		2	1	0	0.160		
	2	2	0	8		3	2	1.24	0.308		
	3	3	1	9		2	3	0	0.003		
	4	4	2	0		4	4	0.67	0.137		
	5	5	3	1		0	5	0	0.000		
	6	6	4	2		5	6	0.24	0.072		
	7	7	5	3		0	7	0	0.000		
2	8	8	6	4		6	8	0.02	0.031	0.090	
	9	9	7	5		2	9	0.08	0.003		
	0	0	8	6		1			0.082		
	1	1	9	7		2			0.160		
	2	2	0	8		3			0.308		
	3	3	1	9		2			0.003		
	4	4	2	0		4			0.137		
	5	5	3	1		0			0.000		
3	6	6	4	2		5			0.072	0.082	
	7	7	5	3		0			0.000		
	8	8	6	4		6			0.031		
	9	9	7	5		2			0.003		
	0	0	8	6		1			0.082		
	1	1	9	7		2			0.160		
	2	2	0	8		3			0.308		
	3	3	1	9		2			0.003		
4	4	4	2	0		4			0.137	0.060	
	5	5	3	1		0			0.000		
	6	6	4	2		5			0.072		
	7	7	5	3		0			0.000		
	8	8	6	4		6			0.031		
	9	9	7	5		2			0.003		
	0	0	8	6		1			0.082		
	1	1	9	7		2			0.160		
5	2	2	0	8		3			0.308	0.069	
	3	3	1	9		2			0.003		
	4	4	2	0		4			0.137		
	5	5	3	1		0			0.000		
	6	6	4	2		5			0.072		
	7	7	5	3		0			0.000		
	8	8	6	4		6			0.031		
	9	9	7	5		2			0.003		

1 hr TWA $=(2 *Ct_0 +2*Ct_8+2*Ct_6)/60$

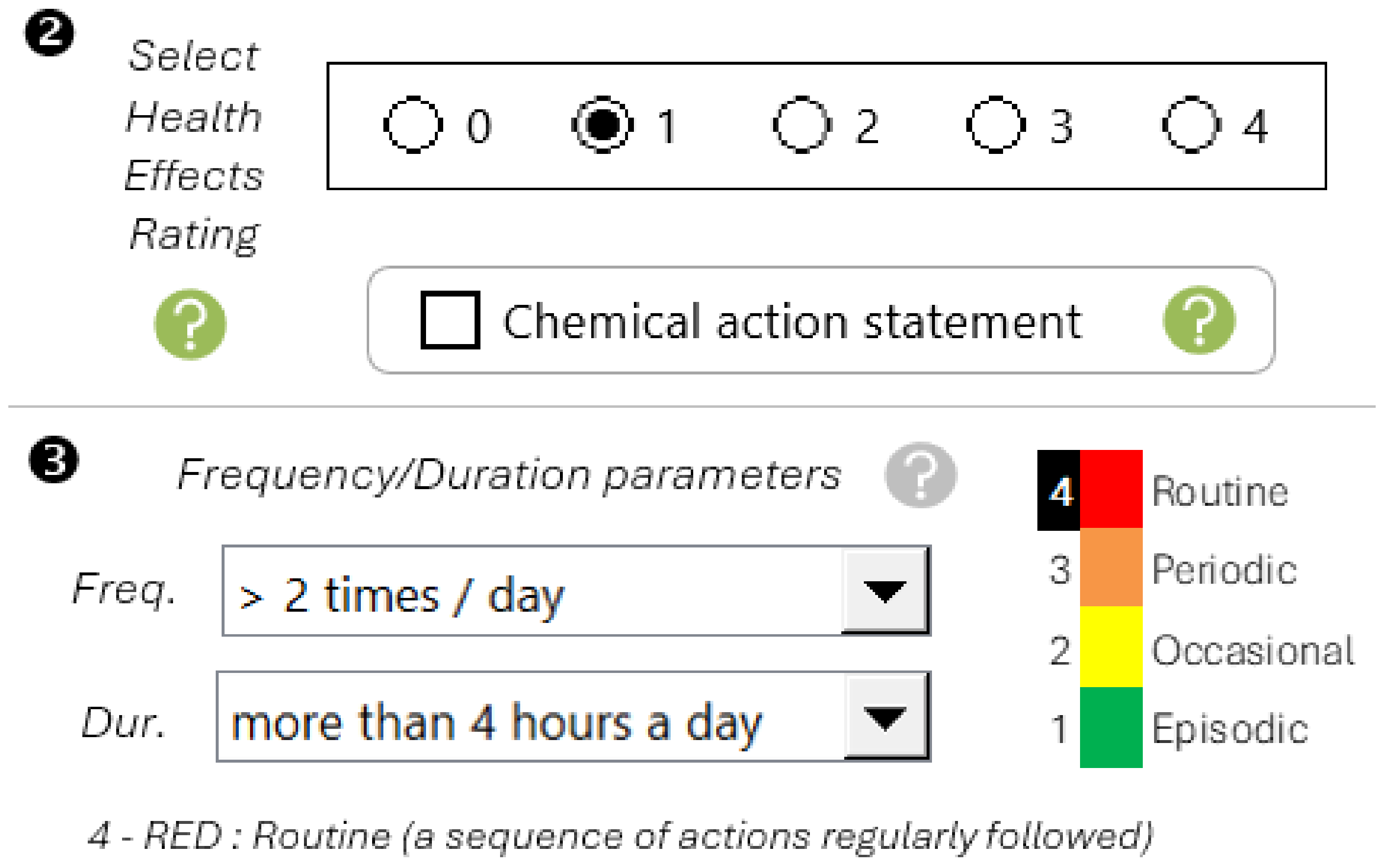
Incorporating Frequency and Duration into Risk Assessment

Level	Color	Freq. X Dur.	Description
1	Green	1 to 9	Episodic
2	Yellow	10 to 18	Occasional
3	Orange	19 to 27	Periodic
4	Red	28 to 36	Routine

Frequency

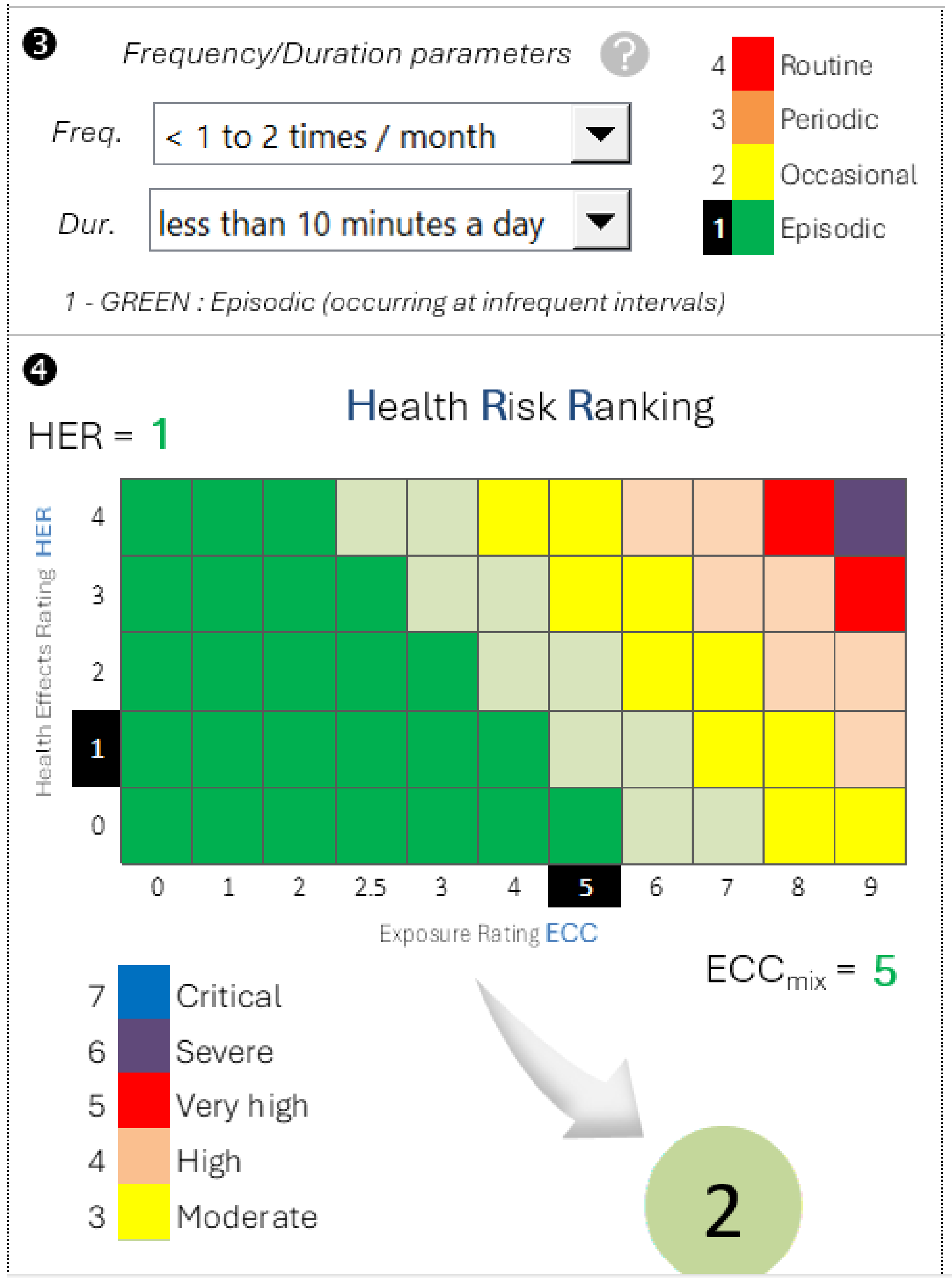
Duration

		1 < 1 to 2 times / month	2 > 2 times / month	3 1 to 2 times / week	4 > 2 times / week	5 1 to 2 times / day	6 > 2 times / day
1	less than 10 minutes a day	1	2	3	4	5	6
2	10 to 30 minutes a day	2	4	6	8	10	12
3	30 to 60 minutes a day	3	6	9	12	15	18
4	1 to 2 hours a day	4	8	12	16	20	24
5	2 to 4 hours a day	5	10	15	20	25	30
6	more than 4 hours a day	6	12	18	24	30	36

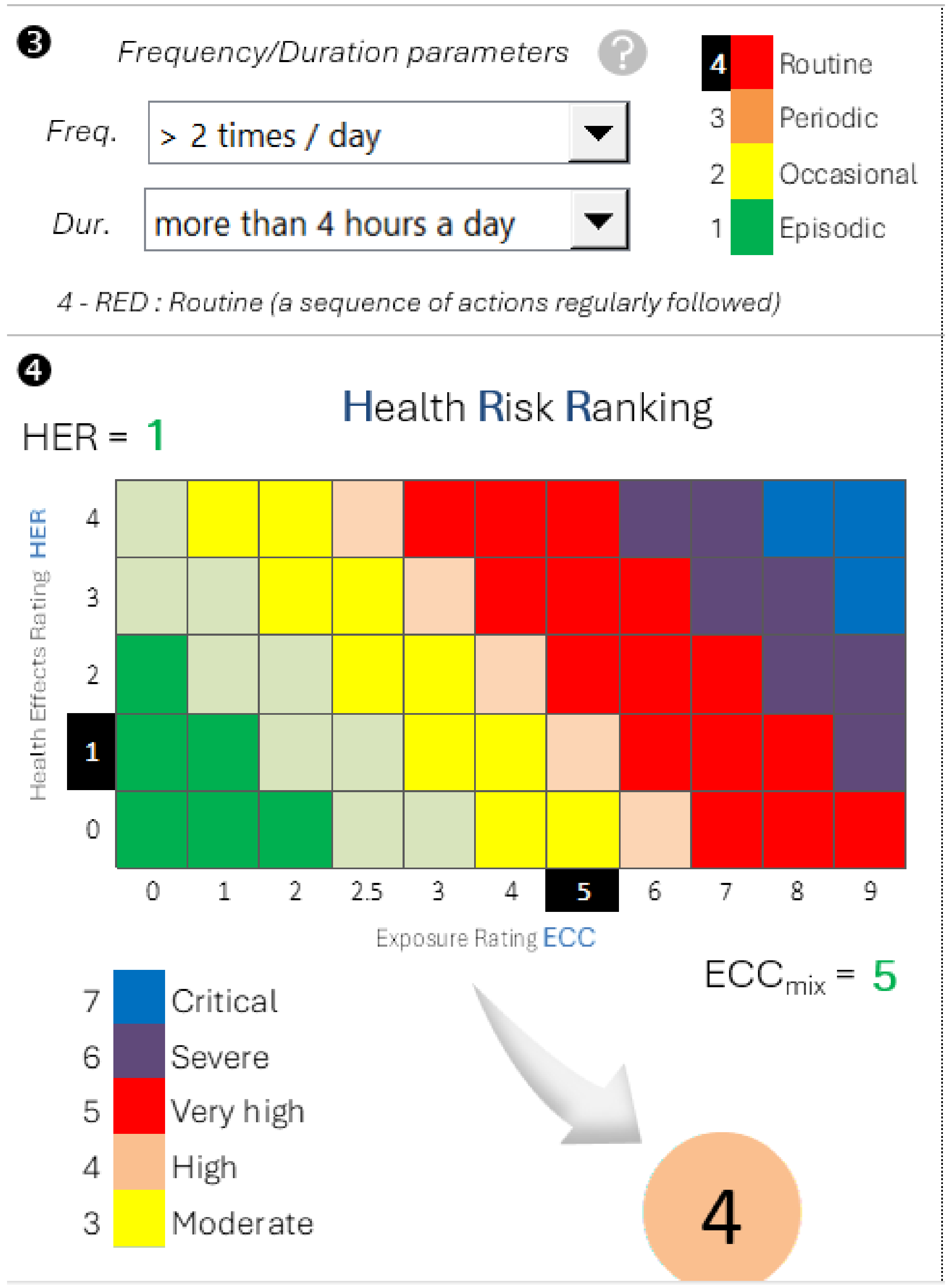


Incorporating Frequency and Duration into Risk Assessment

Episodic task, short duration



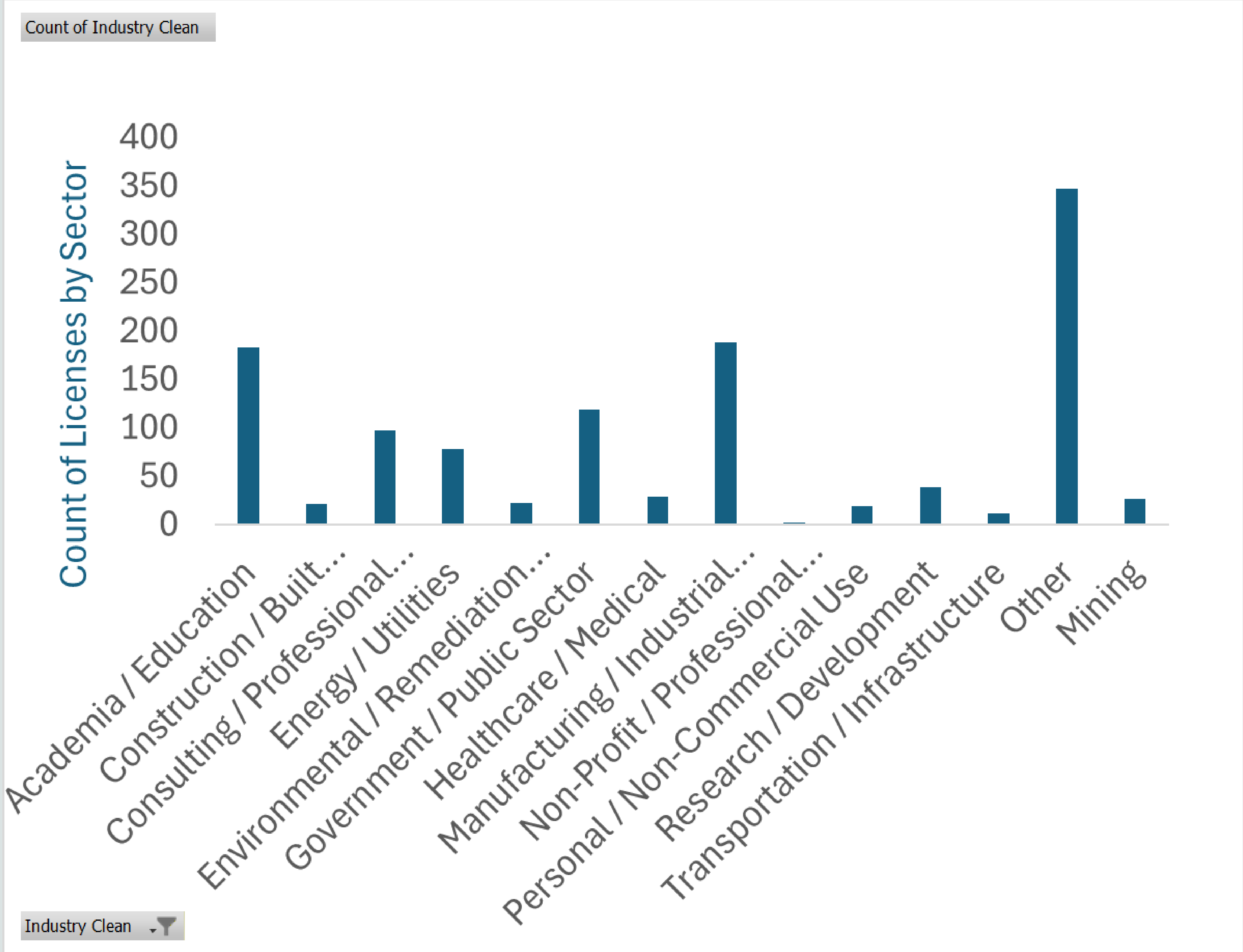
Routine task, longer duration



Who is using SDM 2.0?

1200+ Occupational Hygiene Professionals, worldwide!

Across a range of industry sectors



Summary

The SDM 2.0

- Powerful tool for assessing exposure and health risks for evaluation under TSCA!
- Increases exposure and health risk decision-making accuracy AND productivity
- Addresses exposures to volatile chemicals including chemical mixtures, and aerosols
- Assesses a broad range of exposure scenarios in a timely manner across the value chain
  - Continuous processes
  - Campaigning
  - Batch
  - Permitting
  - Scheduled maintenance
  - Emergency upsets
  - Future/past exposures
  - Work history development
- Breaks down complex exposure scenarios and assesses them, systematically
- Facilitates use of other models (IHEST, IH Mod2.0, ExpoSTAT, IHSTAT-Bayes, etc)
- Increases value of exposure measurement data within Bayesian framework

Accessing SDM 2.0

SDM2.0 Standard
(free)

SDM2.0 Premium
(fee-based)

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Questions?