AIHA™

HEALTHIER WORKPLACES | A HEALTHIER WORLD

AIHA VIDEO SERIES:

MAKING ACCURATE EXPOSURE RISK DECISIONS

VIDEO 4:

IMPLEMENTING AIHA STRATEGY USING STATISTICAL TOOLS: EXAMPLES

Andrew D. Perkins MS, CIH, CSP, COHC

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[next]

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OUTLINE

- Experiences and outcomes
- Simplification of statistical tool use
- Examples comparing statistical tools
- Value provided by AIHA strategy/ statistical tools
- Business case ideas

SUCCESS STORY: ADOPTING AIHA STRATEGY

Background

- Large mining company
- Great Industrial Hygiene program
- NIOSH Sampling Strategy driven
- Drive to continuously improve
- Executive asked the question “Are we sampling too much or to little”

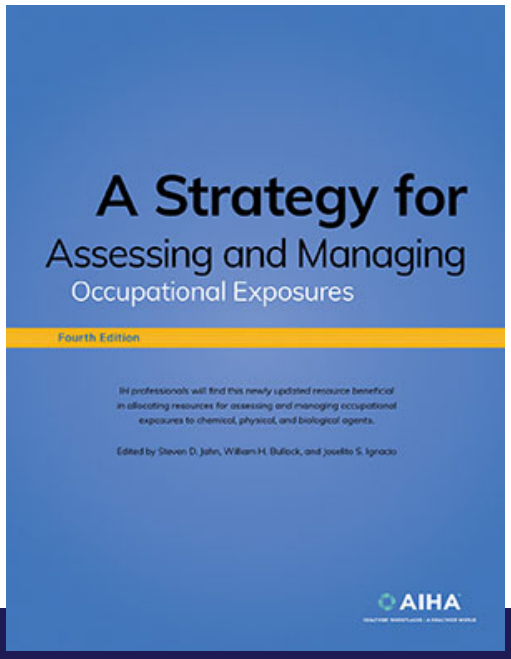
Project

- Assessed options for improvement
- AIHA Sampling Strategy with BDA
- Created/Implemented Program
- Automated
- Trained
- Adjust as needed

Value

- Reduced time investment to create sampling plans
- More confidence with less sampling
- No questions if controlled exposures were in government compliance
- Less unneeded repeat sampling
- More resources to validate lower category sampling priorities
- Category numbers and graphs to simplify risk communication
- Easy to create and understand exposure metrics
- Systematic sampler qualitative judgment coaching on each sample
- **Clear positive step change in Industrial Hygiene program!**

CONCEPT S FROM



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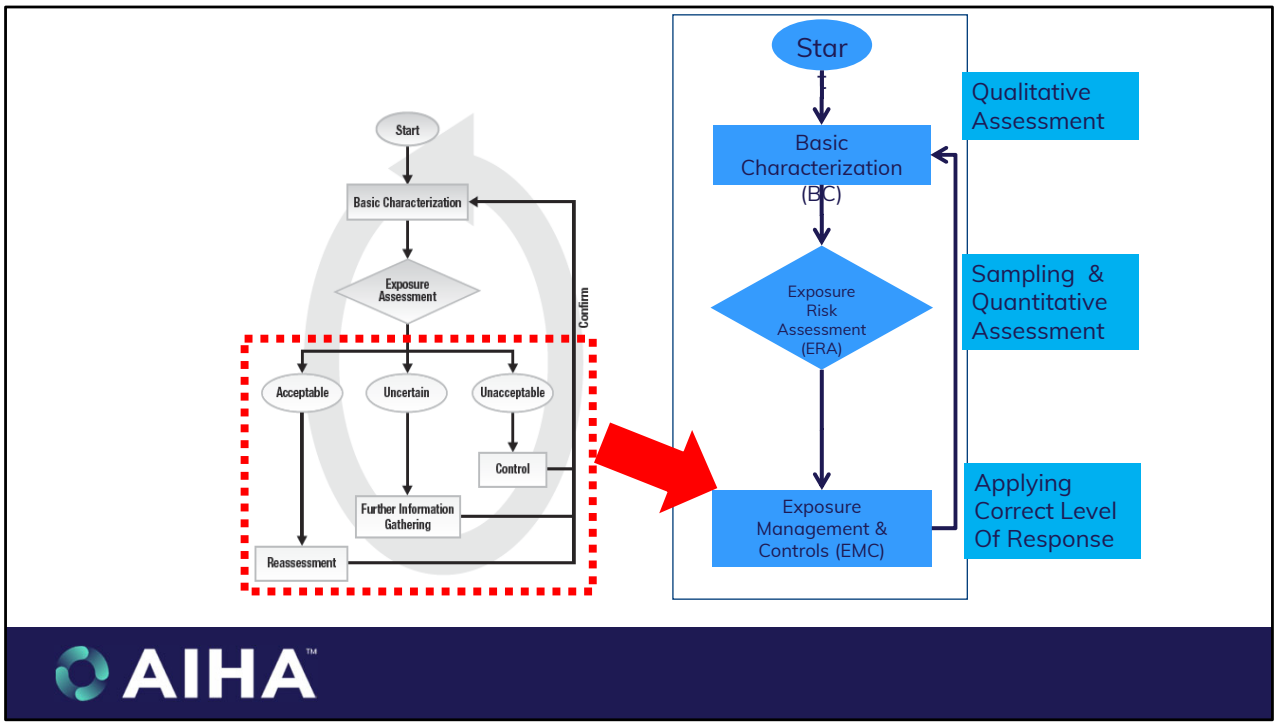
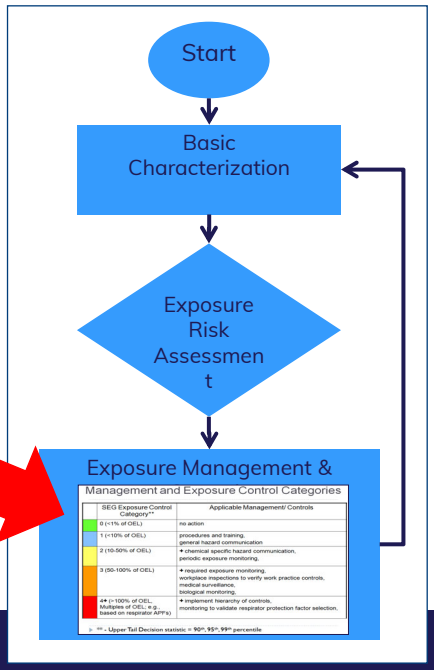

Start
Basic Characterization
Exposure Assessment
Acceptable
Uncertain
Unacceptable
Control
Further Information Gathering
Reassessment
Confirm
Star
Basic Characterization (BC)
Exposure Risk Assessment (ERA)
Exposure Management & Controls (EMC)
Qualitative Assessment
Sampling & Quantitative Assessment
Applying Correct Level Of Response
AIHA

AIHA's Systematic Categorization & Controls Model



EXPOSURE MANAGEMENT & CONTROL CATEGORIES

	SEG Exposure Control Category**	Applicable Management/ Controls
	0 (<1% of OEL)	no action
	1 (<10% of OEL)	pre… …training, … hazard communication
	2 (10-50% of OEL)	+ chemical specific hazard communication, periodic exposure monitoring,
	3 (50-100% of OEL)	+ required exposure monitoring, workplace inspections to verify work practice controls, medical surveillance, biological monitoring,
	4+ (>100% of OEL, Multiples of OEL; e.g., based on respirator APFs)	+ implement hierarchy of controls, monitoring to validate respirator protection factor selection,

Decision Made On Statistical Percentile As % Of OEL

What is more protective 95th or 90th

** - Note: Decisions are made on percentile that fits the organization's risk tolerance level. Upper Tail Decision statistic = 90th, **95th**, 99th percentile

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We can use our Qualitative or Quantitative Judgments to quickly drive controls.

WHAT LEVEL OF EXPOSURE ASSESSOR ARE YOU?

- Only eyeball potential exposures (guess)
- Systematic qualitative assessment of exposures (no samples)
- Quantitative drives my exposure assessments (sampling data/compliance)
- Statistical data analysis is used to inform my exposure assessments (good)
- Systematic qualitative and quantitative data, analyzed using statistical tools, transparent decision logic, well documented and reiterative exposure assessment strategy. (AIHA Sampling Strategy = Great)

DOING THE RIGHT THING?

- Compliance with government regulations does not mean an exposure is acceptable overtime!
- Regulatory compliance as only one hurdle we need to overcome
- Our goal is validated statistical confidence that we are keeping workers safe & healthy every day

CURRENT INDUSTRIAL HYGIENE EXPOSURE ASSESSMENTS STANDARD OF CARE

- Government Regulations
- Consensus Standards
- Corporate/Environmental Standability Governance (ESG)
- Profits Over People vs. Best Practice **(Litigation!)**
- Community/Societal Requirements
- World Class EHS Leader

AIHA Sampling Strategy Can Help You

EXPOSURE JUDGMENT EXAMPLES

What is your qualitative assessment of this exposure? (Category 0, 1, 2, 3, or 4)

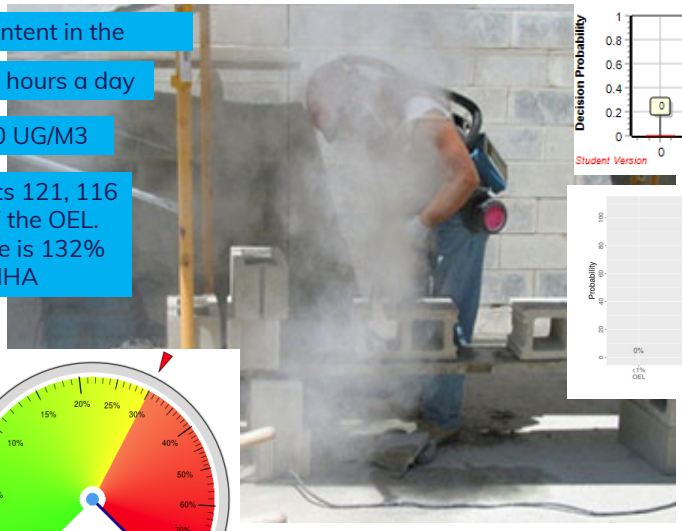
25% Silica content in the block

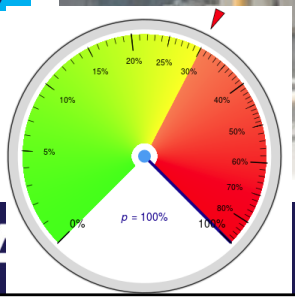
Cuts blocks 2 hours a day

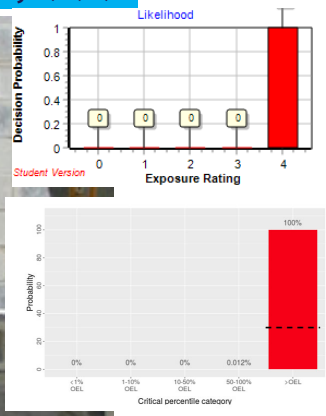
OSHA PEL 50 UG/M3

Sample results 121, 116 and 128 % of the OEL. 95th Percentile is 132% of the OEL. AIHA Category # ?

Category 4







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14

% OF OEL

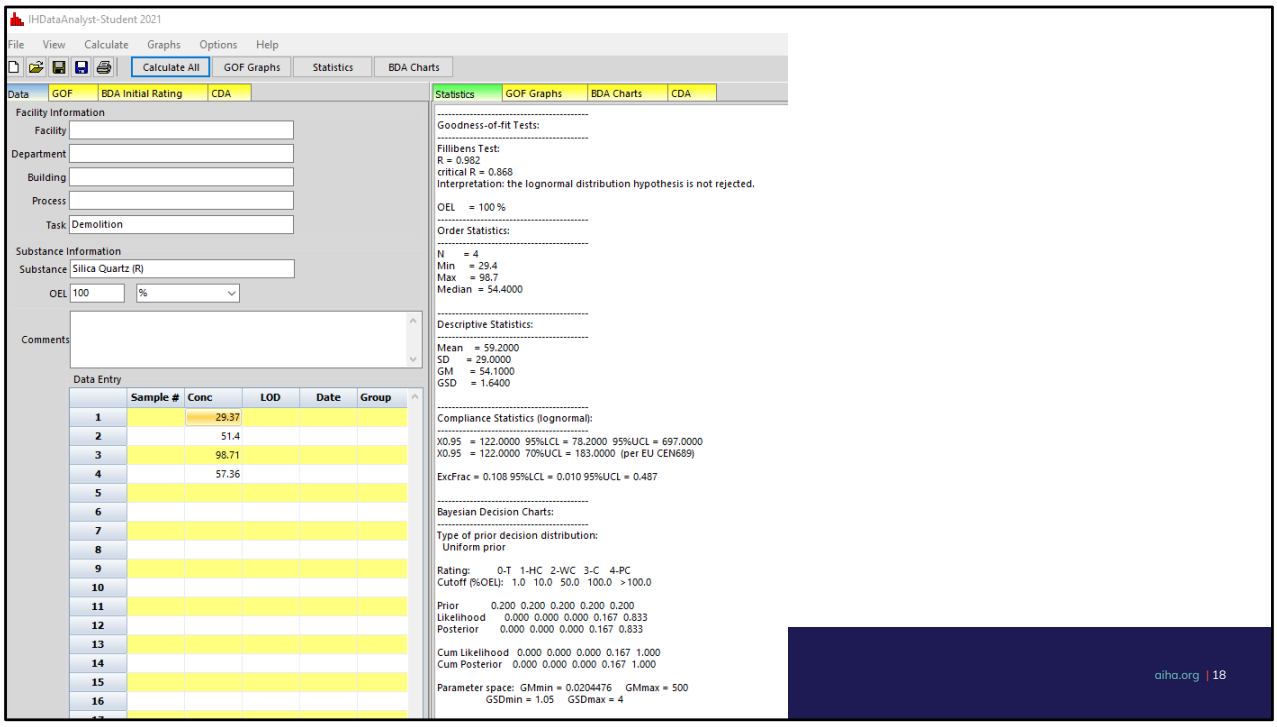
- Exposure/OEL * 100 = %OEL
- Example 35/100 *100 = 35% OEL
- Can be used to simplify analysis
- Helps normalize data (noise, extended shift)

- Example: Ethyl Bromide
- Using ACGIH TLV 5 PPM TWA as OEL
- Results 1.23 PPM TWA? or
- 24.6 % OEL **(Easy to convey results)**

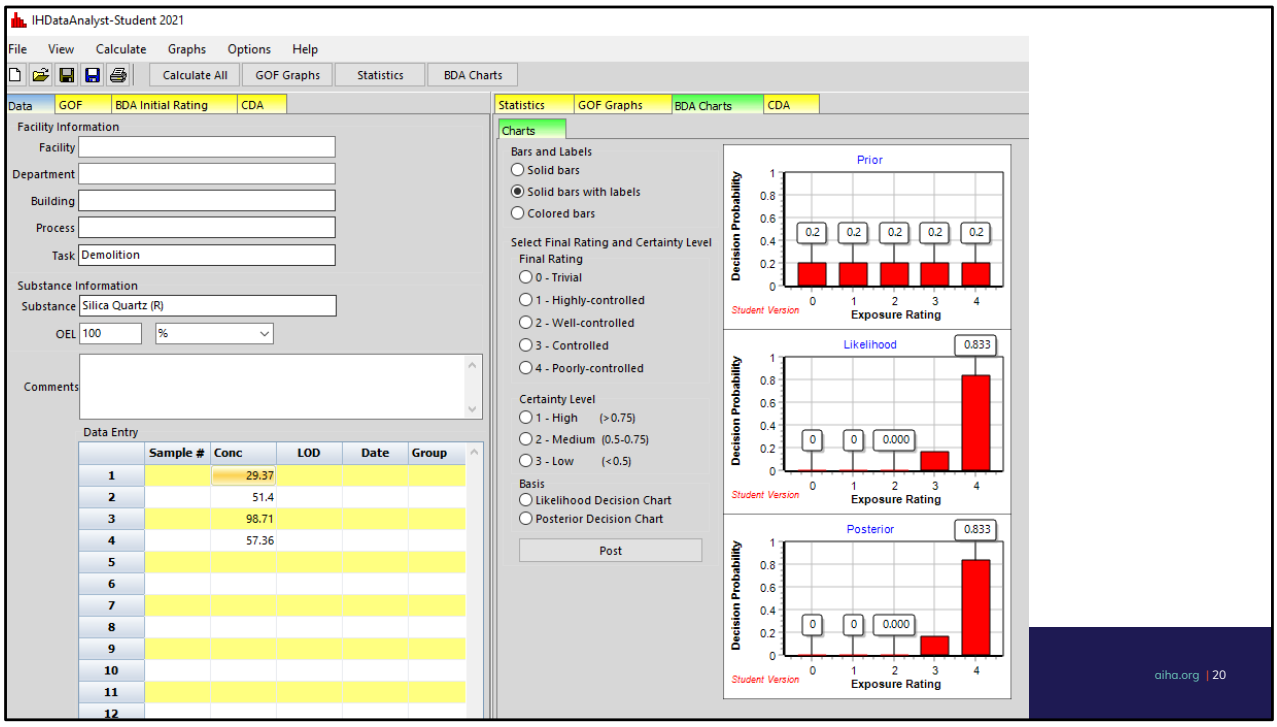
EXAMPLE SEG

SampleType	LimitType	SEG	Nondetect	% of OEL	SampleStatus	Agent
Personal	TWA 10 Hour Shift	Demolition		29.37	Approved	Silica Quartz (R)
Personal	TWA 10 Hour Shift	Demolition		51.4	Approved	Silica Quartz (R)
Personal	TWA 10 Hour Shift	Demolition		98.71	Approved	Silica Quartz (R)
Personal	TWA 10 Hour Shift	Demolition		57.36	Approved	Silica Quartz (R)

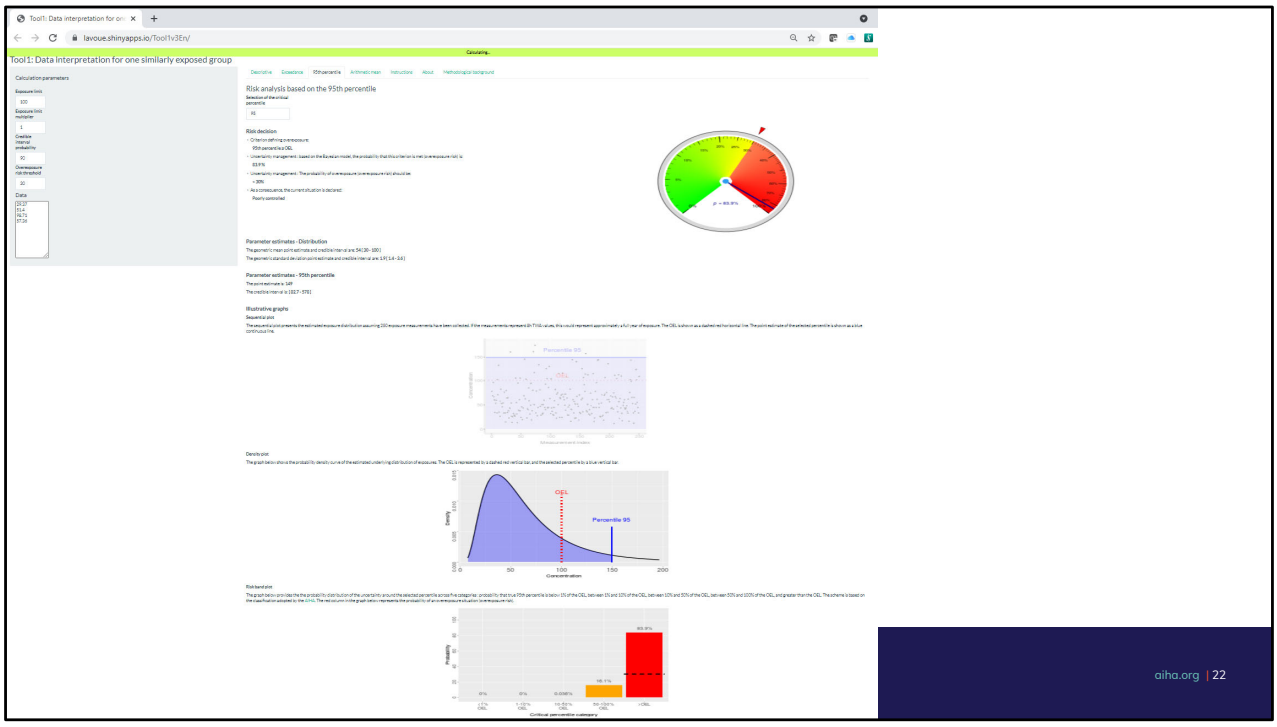
IH DATA ANALYST STUDENT (IHDA STUDENT)

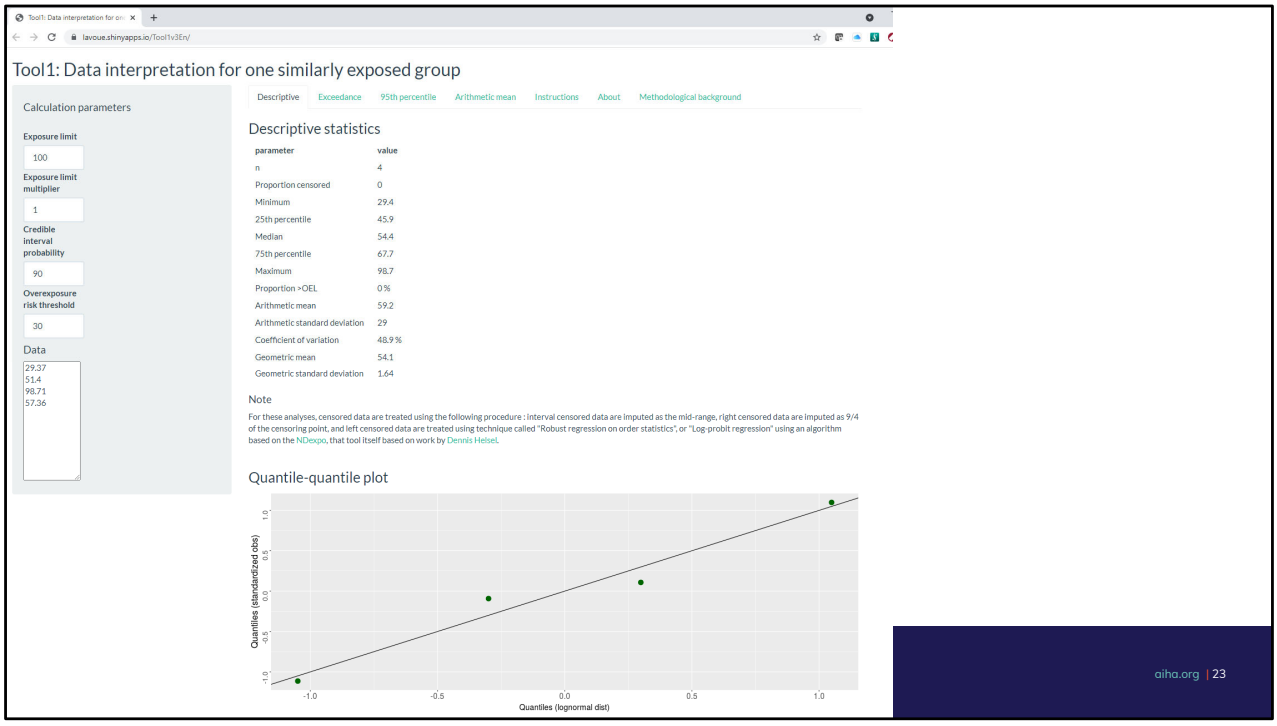

IHDataAnalyst-Student 2021
File View Calculate Graphs Options Help
Calculate All
GOF Graphs
Statistics
BDA Charts
Data
GOF
BDA Initial Rating
CDA
Facility Information
Facility
Department
Building
Process
Task Demolition
Substance Information
Substance Silica Quartz (R)
OEL 100 %
Comments
Data Entry
Sample # Conc LOD Date Group
1 29.37
2 51.4
3 98.71
4 57.36
Statistics
GOF Graphs
BDA Charts
CDA
Goodness-of-fit Tests:
Filliben's Test:
R = 0.982
critical R = 0.868
Interpretation: the lognormal distribution hypothesis is not rejected.
OEL = 100 %
Order Statistics:
N = 4
Min = 29.4
Max = 98.7
Median = 54.4000
Descriptive Statistics:
Mean = 59.2000
SD = 29.0000
GM = 54.1000
GSD = 1.6400
Compliance Statistics (lognormal):
X0.95 = 122.0000 95%LCL = 78.2000 95%UCL = 697.0000
X0.95 = 122.0000 70%UCL = 183.0000 (per EU CEN689)
ExcFrac = 0.108 95%LCL = 0.010 95%UCL = 0.487
Bayesian Decision Charts:
Type of prior decision distribution:
Uniform prior
Rating: 0-T 1-HC 2-WC 3-C 4-PC
Cutoff (%OEL): 1.0 10.0 50.0 100.0 >100.0
Prior 0.200 0.200 0.200 0.200 0.200
Likelihood 0.000 0.000 0.000 0.167 0.833
Posterior 0.000 0.000 0.000 0.167 0.833
Cum Likelihood 0.000 0.000 0.000 0.167 1.000
Cum Posterior 0.000 0.000 0.000 0.167 1.000
Parameter space: GMmin = 0.0204476 GMmax = 500
GSDmin = 1.05 GSDmax = 4


IHDataAnalyst-Student 2021
File View Calculate Graphs Options Help
Calculate All
GOF Graphs
Statistics
BDA Charts
Data
GOF
BDA Initial Rating
CDA
Facility Information
Facility
Department
Building
Process
Task
Demolition
Substance Information
Substance
Silica Quartz (R)
OEL
100
%
Comments
Data Entry
Sample #
Conc
LOD
Date
Group
1 29.37
2 51.4
3 98.71
4 57.36
5
6
7
8
9
10
11
12
Statistics
GOF Graphs
BDA Charts
CDA
Graphs
Time Series
Concentration
Measurement
Student Version
Log-probit
Concentration
Probit
Student Version
Histogram
Count
Concentration
0
49.355
98.71
Student Version


IHDataAnalyst-Student 2021
File View Calculate Graphs Options Help
Calculate All GOF Graphs Statistics BDA Charts
Data GOF BDA Initial Rating CDA
Facility Information
Facility
Department
Building
Process
Task Demolition
Substance Information
Substance Silica Quartz (R)
OEL 100 %
Comments
Data Entry
Sample # Conc LOD Date Group
1 29.37
2 51.4
3 98.71
4 57.36
Statistics GOF Graphs BDA Charts CDA
Charts
Bars and Labels
Solid bars
Solid bars with labels
Colored bars
Select Final Rating and Certainty Level
Final Rating
0 - Trivial
1 - Highly-controlled
2 - Well-controlled
3 - Controlled
4 - Poorly-controlled
Certainty Level
1 - High (>0.75)
2 - Medium (0.5-0.75)
3 - Low (<0.5)
Basis
Likelihood Decision Chart
Posterior Decision Chart
Post
Prior
Likelihood
Posterior
Decision Probability
Exposure Rating
Student Version
0.2
0
0.000
0.833

EXPO STATS TOOL 1:DATA INTERPRETATION FOR ONE SIMILARLY EXPOSED GROUP


Tool1: Data interpretation for one similarly exposed group
Risk analysis based on the 95th percentile
Parameter estimates - Distribution
Parameter estimates - 95th percentile
Illustrative graphs
Sequential plot
Density plot
Risk band plot
OEL
Percentile 95
Density
Concentration
Probability


Tool1: Data interpretation for one similarly exposed group
Calculation parameters
Exposure limit
100
Exposure limit multiplier
1
Credible interval probability
90
Overexposure risk threshold
30
Data
29.37
51.4
98.71
57.36
Descriptive
Exceedance
95th percentile
Arithmetic mean
Instructions
About
Methodological background
Descriptive statistics
parameter
value
n
4
Proportion censored
0
Minimum
29.4
25th percentile
45.9
Median
54.4
75th percentile
67.7
Maximum
98.7
Proportion >OEL
0 %
Arithmetic mean
59.2
Arithmetic standard deviation
29
Coefficient of variation
48.9 %
Geometric mean
54.1
Geometric standard deviation
1.64
Note
For these analyses, censored data are treated using the following procedure : Interval censored data are imputed as the mid-range, right censored data are imputed as 9/4 of the censoring point, and left censored data are treated using technique called "Robust regression on order statistics", or "Log-probit regression" using an algorithm based on the NDexpo, that tool itself based on work by Dennis Helsel.
Quantile-quantile plot
Quantiles (standardized obs)
Quantiles (lognormal dist)

Tool1: Data interpretation for on

lavoue.shinyapps.io/Tool1v3En/

Tool1: Data interpretation for one similarly exposed group

Calculation parameters

Exposure limit

100

Exposure limit multiplier

1

Credible interval probability

90

Overexposure risk threshold

30

Data

29.37
51.4
98.71
57.36

Descriptive | Exceedance | 95th percentile | Arithmetic mean | Instructions | About | Methodological background

Risk analysis based on the 95th percentile

Selection of the critical percentile

95

Risk decision

- Criterion defining overexposure:

  95th percentile ≥ OEL

- Uncertainty management : based on the Bayesian model, the probability that this criterion is met (overexposure risk) is:

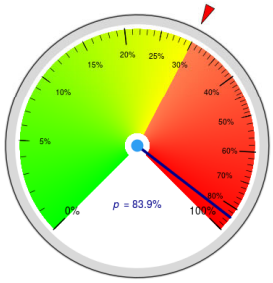
  83.9 %

- Uncertainty management : The probability of overexposure (overexposure risk) should be:

  < 30%

- As a consequence, the current situation is declared:

  Poorly controlled



Parameter estimates - Distribution

The geometric mean point estimate and credible interval are: **54 [30 - 100]**

The geometric standard deviation point estimate and credible interval are: **1.9 [1.4 - 3.6]**

Parameter estimates - 95th percentile

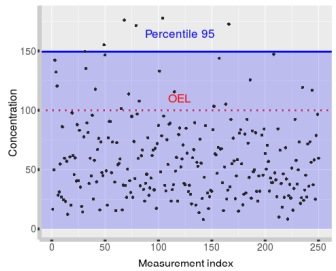
The point estimate is: **149**

The credible interval is: **[82.7 - 578]**

Illustrative graphs

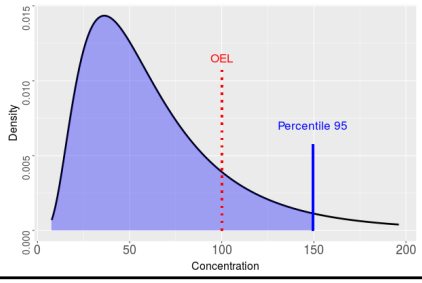
Sequential plot

The sequential plot presents the estimated exposure distribution assuming 250 exposure measurements have been collected. If the measurements represent 8h TWA values, this would represent approximately a full year of exposure. The OEL is shown as a dashed red horizontal line. The point estimate of the selected percentile is shown as a blue continuous line.



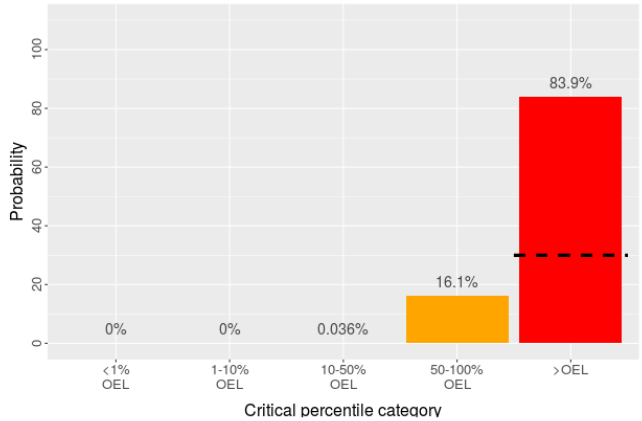
Density plot

The graph below shows the probability density curve of the estimated underlying distribution of exposures. The OEL is represented by a dashed red vertical bar, and the selected percentile by a blue vertical bar.



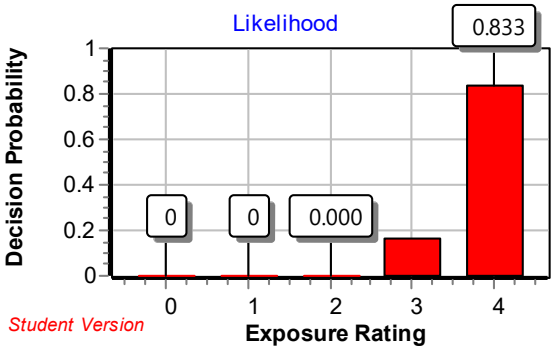
Risk band plot

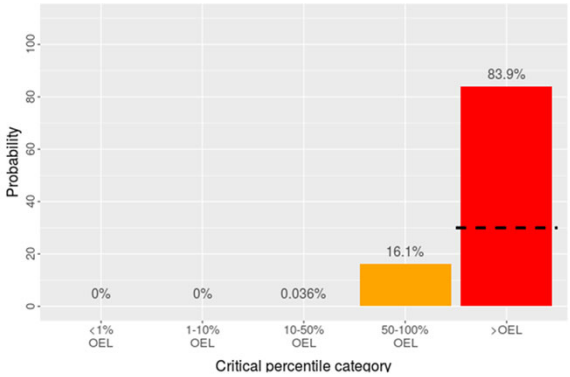
The graph below provides the the probability distribution of the uncertainty around the selected percentile across five categories : probability that true 95th percentile is below 1% of the OEL, between 1% and 10% of the OEL, between 10% and 50% of the OEL, between 50% and 100% of the OEL, and greater than the OEL. The scheme is based on the classification adopted by the AIHA. The red column in the graph below represents the probability of an overexposure situation (overexposure risk).



COMPARISON OF RESULTS

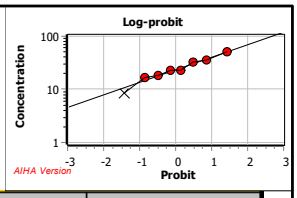
Example SEG Data Sets		IHDA							ExpoStats Tool 1						
SEG	Agent	Cat 0 %	Cat 1 %	Cat 2 %	Cat 3 %	Cat 4 %	GSD*	X0.95*	Cat 0 %	Cat 1 %	Cat 2 %	Cat 3 %	Cat 4 %	GSD**	X0.95**
Demolition	Silica Quartz (R)	0	0	0	16.7	**83.3**	1.64	122	0	0	0.036	16.1	**83.9**	1.9	149





*IHDA Uses Traditional / Frequentist Calculation Methods for Parameter Estimates (GSD, X0.95)

EXAMPLE SEG

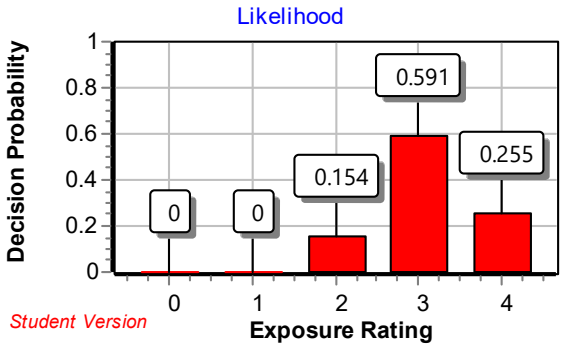


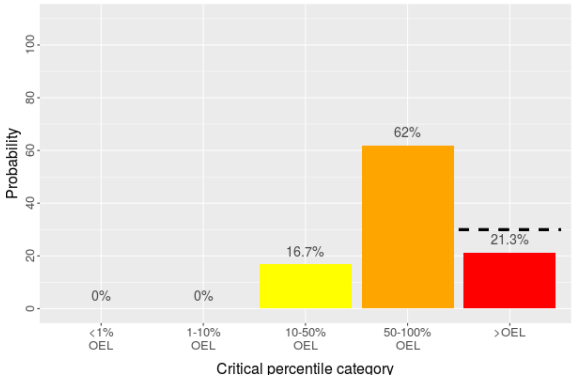
SampleType	LimitType	SEG	Nondetect	% of OEL	SampleStatus	Agent
Personal	TWA 8 Hour Shift	Jackhammer Operation		50.4	Approved	Silica Quartz (R)
Personal	TWA 8 Hour Shift	Jackhammer Operation		22.74	Approved	Silica Quartz (R)
Personal	TWA 8 Hour Shift	Jackhammer Operation		36.1	Approved	Silica Quartz (R)
Personal	TWA 8 Hour Shift	Jackhammer Operation		32.7	Approved	Silica Quartz (R)
Personal	TWA 8 Hour Shift	Jackhammer Operation		23.22	Approved	Silica Quartz (R)
Personal	TWA 8 Hour Shift	Jackhammer Operation		17.04	Approved	Silica Quartz (R)
Personal	TWA 8 Hour Shift	Jackhammer Operation		18.31	Approved	Silica Quartz (R)
Personal	TWA 8 Hour Shift	Jackhammer Operation	<	8.41	Approved	Silica Quartz (R)

COMPARISON OF RESULTS

Example SEG Data Sets		IHDA							ExpoStats Tool 1						
SEG	Agent	Cat 0 %	Cat 1 %	Cat 2 %	Cat 3 %	Cat 4 %	GSD*	X0.95*	Cat 0 %	Cat 1 %	Cat 2 %	Cat 3 %	Cat 4 %	GSD**	X0.95**
Jackhammer Operation	Silica Quartz (R)	0	0	15.4	**59.1**	25.5	2.11	72.7	0	0	16.7	**62**	21.3	2	68.9

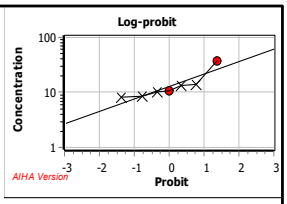
IHDA CDA used substitution with DL/2





*IHDA Uses Traditional / Frequentist Calculation Methods for Parameter Estimates (GSD, X0.95)

EXAMPLE SEG

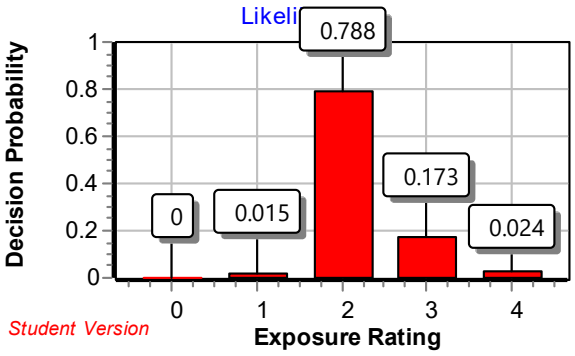


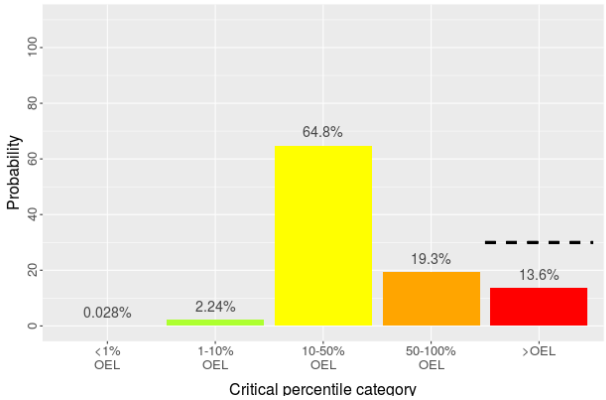
SampleType	LimitType	SEG	Nondetect	% of OEL	SampleStatus	Agent
Personal	TWA 8 Hour Shift	Maintenance Tasks	<	8.27	Approved	Silica Quartz (R)
Personal	TWA 8 Hour Shift	Maintenance Tasks	<	8.38	Approved	Silica Quartz (R)
Personal	TWA 10 Hour Shift	Maintenance Tasks	<	14.23	Approved	Silica Quartz (R)
Personal	TWA 10 Hour Shift	Maintenance Tasks	<	13.35	Approved	Silica Quartz (R)
Personal	TWA 8 Hour Shift	Maintenance Tasks	<	10.31	Approved	Silica Quartz (R)
Personal	TWA 8 Hour Shift	Maintenance Tasks		38.03	Approved	Silica Quartz (R)
Personal	TWA 8 Hour Shift	Maintenance Tasks		10.63	Approved	Silica Quartz (R)

COMPARISON OF RESULTS

Example SEG Data Sets		IHDA							ExpoStats Tool 1						
SEG	Agent	Cat 0 %	Cat 1 %	Cat 2 %	Cat 3 %	Cat 4 %	GSD*	X0.95*	Cat 0 %	Cat 1 %	Cat 2 %	Cat 3 %	Cat 4 %	GSD**	X0.95**
Maintenance Tasks	Silica Quartz (R)	0	1.5	**78.8**	17.3	2.4	2.55	49.4	0.028	2.24	**64.8**	19.3	13.6	3.5	35.5

IHDA CDA used LPR (log-probit regression)

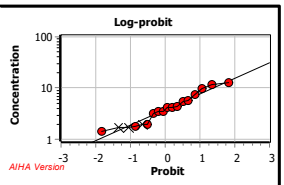




*IHDA Uses Traditional / Frequentist Calculation Methods for Parameter Estimates (GSD, X0.95)

EXAMPLE SEG

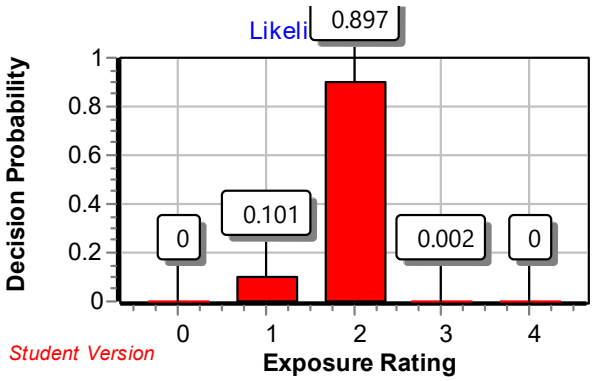
SEG	% of OEL	Nondetect	ExpoStats	SampleStatus	Agent
Cleaning/Housekeeping	4.2		4.2	Approved	Respirable Dust
Cleaning/Housekeeping	4.34		4.34	Approved	Respirable Dust
Cleaning/Housekeeping	4.14		4.14	Approved	Respirable Dust
Cleaning/Housekeeping	5.49		5.49	Approved	Respirable Dust
Cleaning/Housekeeping	11.83		11.83	Approved	Respirable Dust
Cleaning/Housekeeping	7.34		7.34	Approved	Respirable Dust
Cleaning/Housekeeping	5.74		5.74	Approved	Respirable Dust
Cleaning/Housekeeping	12.51		12.51	Approved	Respirable Dust
Cleaning/Housekeeping	9.94		9.94	Approved	Respirable Dust
Cleaning/Housekeeping	3.5		3.5	Approved	Respirable Dust
Cleaning/Housekeeping	1.4		1.4	Approved	Respirable Dust
Cleaning/Housekeeping	1.68	<	<1.68	Approved	Respirable Dust
Cleaning/Housekeeping	1.74		1.74	Approved	Respirable Dust
Cleaning/Housekeeping	1.72	<	<1.72	Approved	Respirable Dust
Cleaning/Housekeeping	3.12		3.12	Approved	Respirable Dust
Cleaning/Housekeeping	1.89	<	<1.89	Approved	Respirable Dust
Cleaning/Housekeeping	3.4		3.4	Approved	Respirable Dust
Cleaning/Housekeeping	1.96		1.96	Approved	Respirable Dust

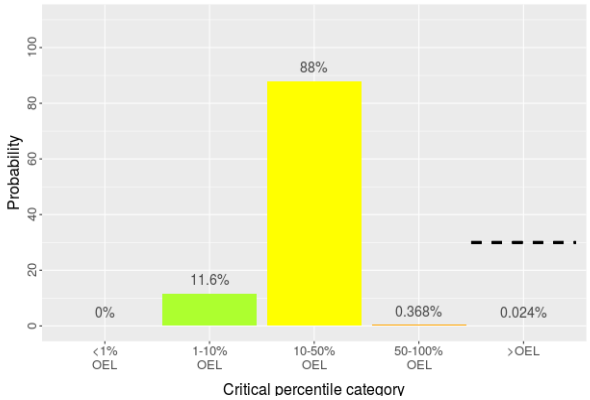


COMPARISON OF RESULTS

Example SEG Data Sets		IHDA							ExpoStats Tool 1						
SEG	Agent	Cat 0 %	Cat 1 %	Cat 2 %	Cat 3 %	Cat 4 %	GSD*	X0.95*	Cat 0 %	Cat 1 %	Cat 2 %	Cat 3 %	Cat 4 %	GSD**	X0.95**
Cleaning/Housekeeping	Respirable Dust	0	10.1	**89.7**	0.02	0	2.37	13.9	0	11.6	**88**	0.368	0.024	2.3	13.8

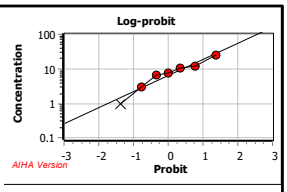
IHDA CDA used substitution with DL/2





*IHDA Uses Traditional / Frequentist Calculation Methods for Parameter Estimates (GSD, X0.95)

EXAMPLE SEG

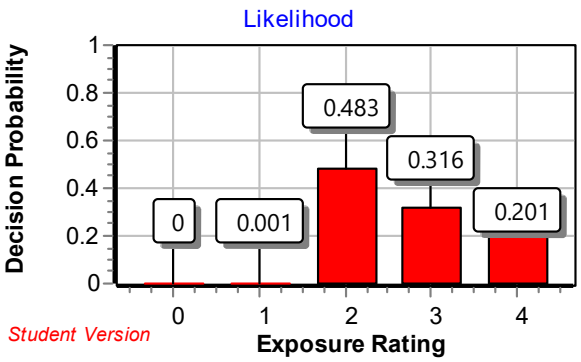


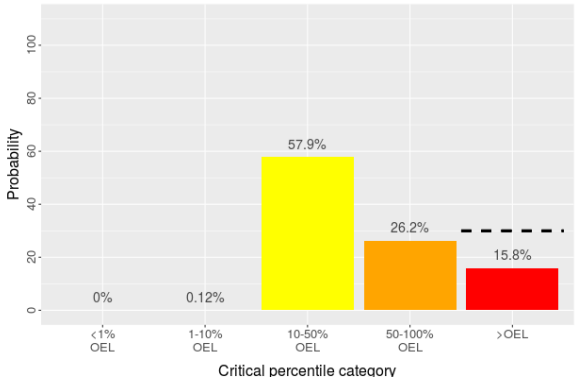
SampleType	LimitType	SEG	Nondetect	% of OEL	SampleStatus	Agent
Personal	TWA 8 Hour Shift	Concrete Sawing - Dry		25.88	Approved	Respirable Dust
Personal	TWA 8 Hour Shift	Concrete Sawing - Dry		10.76	Approved	Respirable Dust
Personal	TWA 8 Hour Shift	Concrete Sawing - Dry		3.07	Approved	Respirable Dust
Personal	TWA 10 Hour Shift	Concrete Sawing - Dry	<	0.96	Approved	Respirable Dust
Personal	TWA 8 Hour Shift	Concrete Sawing - Dry		7.58	Approved	Respirable Dust
Personal	TWA 8 Hour Shift	Concrete Sawing - Dry		12.08	Approved	Respirable Dust
Personal	TWA 8 Hour Shift	Concrete Sawing - Dry		6.82	Approved	Respirable Dust

COMPARISON OF RESULTS

Example SEG Data Sets		IHDA							ExpoStats Tool 1						
SEG	Agent	Cat 0 %	Cat 1 %	Cat 2 %	Cat 3 %	Cat 4 %	GSD*	X0.95*	Cat 0 %	Cat 1 %	Cat 2 %	Cat 3 %	Cat 4 %	GSD**	X0.95**
Concrete Sawing - Dry	Respirable Dust	0	0.1	**48.3**	31.6	20.1	3.61	48.8	0	0.12	**57.9**	26.2	15.8	3.3	43.2

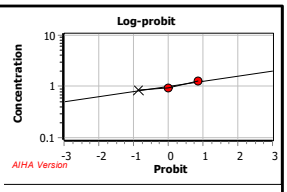
IHDA CDA used substitution with DL/2
IHDA Parameter Space Set to GSD_{max}=7





*IHDA Uses Traditional / Frequentist Calculation Methods for Parameter Estimates (GSD, X0.95)

EXAMPLE SEG

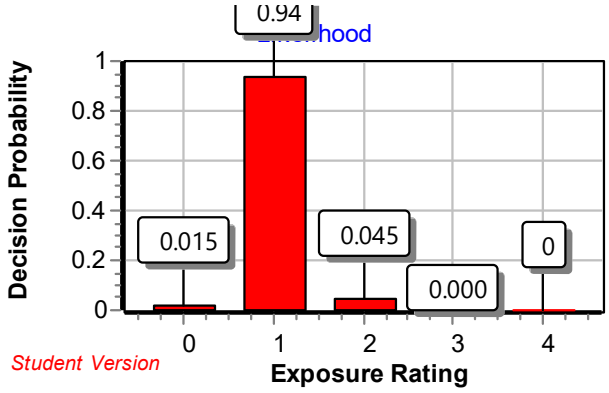


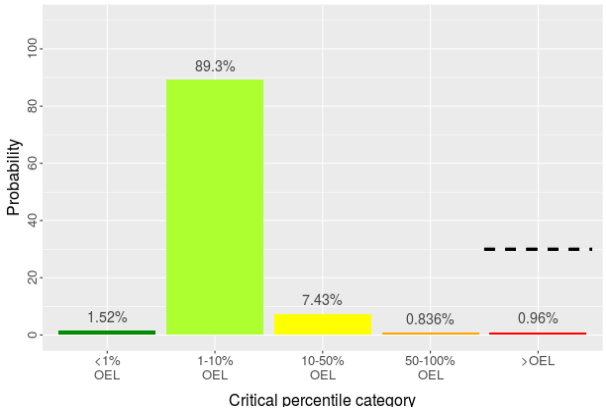
SampleType	LimitType	SEG	Nondetect	% of OEL	SampleStatus	Agent
Personal	TWA 8 Hour Shift	Concrete Sawing - Wet	<	0.84	Approved	Respirable Dust
Personal	TWA 8 Hour Shift	Concrete Sawing - Wet		0.92	Approved	Respirable Dust
Personal	TWA 8 Hour Shift	Concrete Sawing - Wet		1.29	Approved	Respirable Dust

COMPARISON OF RESULTS

Example SEG Data Sets		IHDA							ExpoStats Tool 1						
SEG	Agent	Cat 0 %	Cat 1 %	Cat 2 %	Cat 3 %	Cat 4 %	GSD*	X0.95*	Cat 0 %	Cat 1 %	Cat 2 %	Cat 3 %	Cat 4 %	GSD**	X0.95**
Concrete Sawing - Wet	Respirable Dust	1.5	**94**	4.5	0	0	1.78	2.04	1.52	**89.3**	7.43	0.836	0.96	2	2.48

IHDA CDA used substitution with DL/2





*IHDA Uses Traditional / Frequentist Calculation Methods for Parameter Estimates (GSD, X0.95)

SUMMARY OF EXAMPLE DATA ANALYSIS

Slight Difference in Outputs - Same Overall Exposure Risk

Example SEG Data Sets		IHDA							ExpoStats Tool 1						
SEG	Agent	Cat 0 %	Cat 1 %	Cat 2 %	Cat 3 %	Cat 4 %	GSD*	X0.95*	Cat 0 %	Cat 1 %	Cat 2 %	Cat 3 %	Cat 4 %	GSD**	X0.95**
Demolition	Silica Quartz (R)	0	0	0	16.7	**83.3**	1.64	122	0	0	0.036	16.1	**83.9**	1.9	149
Jackhammer Operation	Silica Quartz (R)	0	0	15.4	**59.1**	25.5	2.11	72.7	0	0	16.7	**62**	21.3	2	68.9
Maintenance Tasks	Silica Quartz (R)	0	1.5	**78.8**	17.3	2.4	2.55	49.4	0.028	2.24	**64.8**	19.3	13.6	3.5	35.5
Cleaning/Housekeeping	Respirable Dust	0	10.1	**89.7**	0.02	0	2.37	13.9	0	11.6	**88**	0.368	0.024	2.3	13.8
Concrete Sawing - Dry	Respirable Dust	0	0.1	**48.3**	31.6	20.1	3.61	48.8	0	0.12	**57.9**	26.2	15.8	3.3	43.2
Concrete Sawing - Wet	Respirable Dust	1.5	**94**	4.5	0	0	1.78	2.04	1.52	**89.3**	7.43	0.836	0.96	2	2.48

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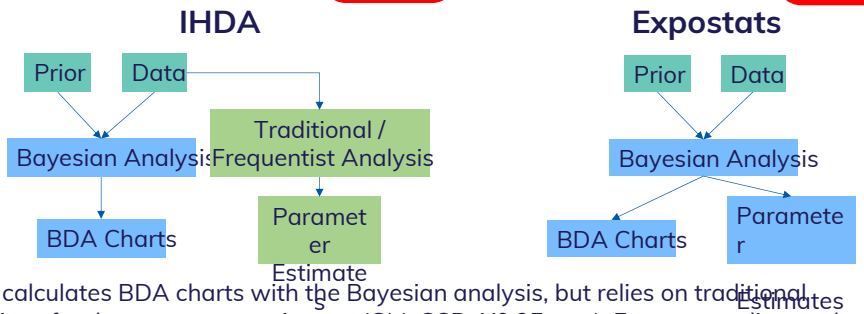
SUMMARY OF EXAMPLE DATA ANALYSIS

Slight Difference in Outputs - Same Overall Exposure Risk Decision

Exposure Data Sets		IHDA							ExpoStats Tool 1						
SEG	Agent	Cat 0 %	Cat 1 %	Cat 2 %	Cat 3 %	Cat 4 %	GSD*	X0.95*	Cat 0 %	Cat 1 %	Cat 2 %	Cat 3 %	Cat 4 %	GSD**	X0.95**
Demolition	Silica Quartz (R)	0	0	0	16.7	83.3	1.64	122	0	0	0.036	16.1	83.9	1.9	149
Jackhammer Operation	Silica Quartz (R)	0	0	15.4	59.1	25.5	2.11	72.7	0	0	16.7	62	21.3	2	68.9
Maintenance Tasks	Silica Quartz (R)	0	1.5	78.8	17.3	2.4	2.55	49.4	0.028	2.24	64.8	19.3	13.6	3.5	35.5
Cleaning/Housekeeping	Respirable Dust	0	10.1	89.7	0.02	0	2.37	13.9	0	11.6	88	0.368	0.024	2.3	13.8
Concrete Sawing - Dry	Respirable Dust	0	0.1	48.3	31.6	20.1	3.61	48.8	0	0.12	57.9	26.2	15.8	3.3	43.2
Concrete Sawing - Wet	Respirable Dust	1.5	94	4.5	0	0	1.78	2.04	1.52	89.3	7.43	0.836	0.96	2	2.48

Statistical Parameter Estimates: Differences Due to Different Calculation Approaches



IHDA calculates BDA charts with the Bayesian analysis, but relies on traditional equations for the parameter estimates (GM, GSD, X0.95, etc.). Expostats relies on the

SUMMARY OF EXAMPLE DATA ANALYSIS

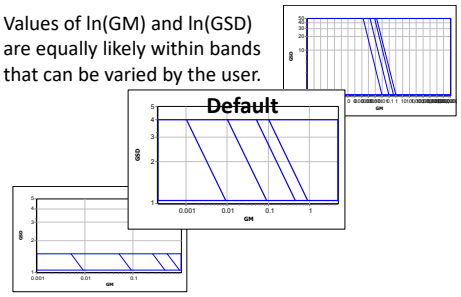
Slight Difference in Outputs - Same Overall Exposure Risk Decision

Exposure Group Data Sets		IHDA							ExpoStats Tool 1						
SEG	Agent	Cat 0 %	Cat 1 %	Cat 2 %	Cat 3 %	Cat 4 %	GSD*	X0.95*	Cat 0 %	Cat 1 %	Cat 2 %	Cat 3 %	Cat 4 %	GSD**	X0.95**
Demolition	Silica Quartz (R)	0	0	0	16.7	**83.3**	1.64	122	0	0	0.036	16.1	**83.9**	1.9	149
Jackhammer Operation	Silica Quartz (R)	0	0	15.4	**59.1**	25.5	2.11	72.7	0	0	16.7	**62**	21.3	2	68.9
Maintenance Tasks	Silica Quartz (R)	0	1.5	**78.8**	17.3	2.4	2.55	49.4	0.028	2.24	**64.8**	19.3	13.6	3.5	35.5
Cleaning/Housekeeping	Respirable Dust	0	10.1	**89.7**	0.02	0	2.37	13.9	0	11.6	**88**	0.368	0.024	2.3	13.8
Concrete Sawing - Dry	Respirable Dust	0	0.1	**48.3**	31.6	20.1	3.61	48.8	0	0.12	**57.9**	26.2	15.8	3.3	43.2
Concrete Sawing - Wet	Respirable Dust	1.5	**94**	4.5	0	0	1.78	2.04	1.52	**89.3**	7.43	0.836	0.96	2	2.48

BDA Charts:
Differences Due to Different Parameter Space Design Choices

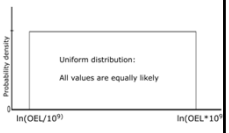
IHDA

Values of ln(GM) and ln(GSD) are equally likely within bands that can be varied by the user.

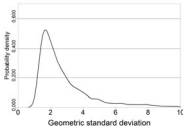


Expostats

Values of ln(GM) are equally likely in a very wide range that users cannot change



GSD fixed with relative plausability consistent with a historical database



SUMMARY OF EXAMPLE DATA ANALYSIS

Slight Difference in Outputs - Same Overall Exposure Risk Decision!

Example SEG Data Sets		IHDA							ExpoStats Tool 1						
SEG	Agent	Cat 0 %	Cat 1 %	Cat 2 %	Cat 3 %	Cat 4 %	GSD*	X0.95*	Cat 0 %	Cat 1 %	Cat 2 %	Cat 3 %	Cat 4 %	GSD**	X0.95**
Demolition	Silica Quartz (R)	0	0	0	16.7	83.3							83.9	1.9	149
Jackhammer Operation	Silica Quartz (R)	0	0	15.4	59.1								62	21.3	2	68.9
Maintenance Tasks	Silica Quartz (R)	0	1.5	78.8									64.8	19.3	13.6	3.5	35.5
Cleaning/Housekeeping	Respirable Dust	0	10.1	89.7									88	0.368	0.024	2.3	13.8
Concrete Sawing - Dry	Respirable Dust	0	0.1	48.3									57.9	26.2	15.8	3.3	43.2
Concrete Sawing - Wet	Respirable Dust	1.5	94									89.3	7.43	0.836	0.96	2	2.48

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Same AIHA Exposure Rating and Control Category Outcomes

SUMMARY OF EXAMPLE DATA ANALYSIS

Slight Difference in Outputs - Same Overall Exposure Risk Decision!

Example SEG Data Sets		IHDA							ExpoStats Tool 1						
SEG	Agent	Cat 0 %	Cat 1 %	Cat 2 %	Cat 3 %	Cat 4 %	GSD*	X0.95*	Cat 0 %	Cat 1 %	Cat 2 %	Cat 3 %	Cat 4 %	GSD**	X0.95**
Demolition	Silica Quartz (R)	0	0	0	16.7	83.3							83.9	1.9	149
Jackhammer Operation	Silica Quartz (R)	0	0	15.4	59.1								62	21.3	2	68.9
Maintenance Tasks	Silica Quartz (R)	0	1.5	78.8									64.8	19.3	13.6	3.5	35.5
Cleaning/Housekeeping	Respirable Dust	0	10.1	89.7									88	0.368	0.024	2.3	13.8
Concrete Sawing - Dry	Respirable Dust	0	0.1	48.3									57.9	26.2	15.8	3.3	43.2
Concrete Sawing - Wet	Respirable Dust	1.5	94									89.3	7.43	0.836	0.96	2	2.48

Bottom Line:

- IHDA and Expostats are extremely useful tools that leverage Bayesian data analysis to help practitioners perform more effective and efficient exposure assessment.
- The differences in interface and mathematical design decisions should not impact the results of a careful risk

AIHA SAMPLING STRATEGY MAKES IH MORE VALUABLE TO YOUR ORGANIZATION

DRIVEN BY: THE PROCESS AND STATISTICAL TOOLS

MADE POSSIBLE BY YOU PUSHING FOR CONTINUOUS IMPROVEMENT

VALUE

- Universal exposure assessment communication
- Is the standard of care exposure assessment
- Increased confidence in decisions
- Quicker decision
- Clearer definition of actions
- Controls easier to define and implement

EARNING BUY IN

- Gain knowledge/understand of AIHA Sampling Strategy
- Deep understanding of decision makers motivators
- Clear communication or your goals/needs
- Show return on investment (ROI). Invest now to prevent major issues later
- Value of this investment now

CLOSING QUESTION

Why use the AIHA Sampling Strategy?

AIHA™

AIHA VIDEO SERIES:
MAKING ACCURATE EXPOSURE RISK DECISIONS

Join us for the entire video series!

Video 1A: Exposure Variability and the Importance of Using Statistics to Improve Judgements

Video 1B: Rules of Thumb for Interpreting Exposure Monitoring Data

Video 2: Introduction to Bayesian Statistical Approaches and Their Advantages

Video 3A: Free Bayesian Statistical Tools: IHDA Student Edition

Video 3B: Free Bayesian Statistical Tools: Expostats

Video 4: Implementing AIHA Strategy Using Statistical Tools: Examples

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EXPOSURE DECISION ANALYSIS

AIHA Registry PROGRAMS™

Exposure Decision Criteria
- Allowable Exceedance
- Needed Confidence
- Use of Exposure Categories

Traditional Industrial Hygiene Stats
- Properties of a lognormal distribution
- Upper percentile estimate calculation & interpretation
- Tolerance Limit calculation & interpretation

Bayesian Decision Analysis (BDA)
- Properties of a lognormal distribution
- Upper percentile estimate calculation & interpretation
- Tolerance Limit calculation & interpretation

Data and Similar Exposure Groups (SEGs)
- Rules for combining data

Decision Heuristics and Human Biases
- Common sources of bias in data interpretation and exposure assessment
- How to avoid bias in data interpretation

Exposure Data Interpretation
- Most likely exposure category given data
- Meet the certainty requirement given data

Techniques for Improving Professional Judgments
- Feedback loops (quantitative judgment > monitoring > qualitative judgment)
- Group judgment sessions
- Documentation of rationale
- Break decisions into aggregate parts (Moc

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KEY RESOURCES

FREE IH STATISTICAL ANALYSIS TOOLS

- **AIHA IHSTAT™:** Excel application that calculates various exposure statistics
https://www.aiha.org/public-resources/consumer-resources/topics-of-interest/ih-apps-tools

- **IH Data Analyst (IHDA) Student Edition:** Bayesian IH Data Analyst Tool
https://www.easinc.co/

- **Expostats:** Bayesian IH Data Analyst Tool
http://expostats.ca/site/en/index.html

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CONNECT WITH THE AIHA EXPOSURE ASSESSMENT STRATEGY COMMUNITY

- Get the book *A Strategy for Assessing and Managing Occupational Exposures, 4th edition*
- Take part in AIHA exposure assessment eLearning
- PDCs and attend AIHce
- AIHA Exposure Assessment Strategies Committee
- Learn to use the statistical tools
- Network with AIHA sampling strategy practitioners
- Academic programs that teach or encourage them to teach AIHA sampling strategy

THANK YOU!