Turning Data into Information

Paul Wambach
Email: PFWambach@verizon.net
Phone: 240-644-7081

02/28/2022

AIHA
UNIVERSITY.

Data Analysis Versus Statistics

- Data Analysis: The process of inspecting, cleansing, transforming, and modeling data with the goal of discovering useful information, informing conclusions, and supporting decision-making

- Retrospective.

- Hypotheses forming

- Use data created by exposure management for a secondary purpose.

- Statistics: Experimental design and decision logic. Control error rates to some acceptable level ($p < 0.05$.)

- Prospective.

- Hypotheses testing

- Plan exposure monitoring to meet data quality objectives needed to manage exposures.

2

AIHA
UNIVERSITY.

Simplifying Assumptions

- Exposure monitoring results representative of typical work are unbiased.

- Measures an organization's success in managing exposure

  - Not an assessment of any individual's actual exposure level

  - The determinants of exposure are assumed to have been identified, evaluated and controlled by the organization's health protection program

3

AIHA
UNIVERSITY.

Distribution Assumptions

- Normal Distribution – Exposure Monitoring Results for Noise

  - Sound level is measured on a log scale

- Lognormal Distribution – Exposure Monitoring Results from a Similarly Exposed Group (SEG)

  - Non-zero results skewed by excursions

- Non-Parametric – Exposure Monitoring Results from Non-routine Operations

  - Goodness of fit analyses does not support the use of the lognormal model

  - Administratively defined groups who perform a variety of jobs and
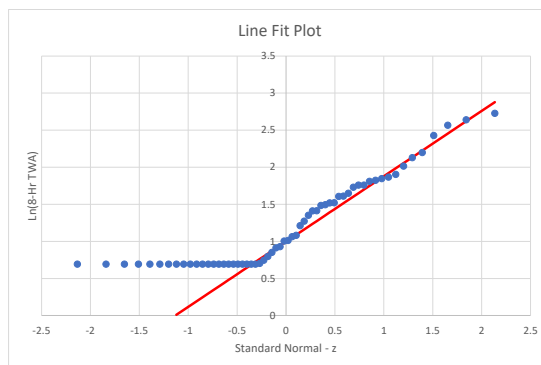
4

AIHA
UNIVERSITY.

Lognormal Distribution

- When exposures are monitored, predictable sources are controlled

- Risk is driven by hard to predict excursions

- The percent rank of the largest result is n/(n+1) -> 19/20 = 0.95

- When n < 19 the 95th percentile is larger than the largest result

- What is happening in unmeasured exposure periods?

Mode = 3
Median (GM) = 10
Mean = 21
95th Percentile = 76

5

AIHA
UNIVERSITY.
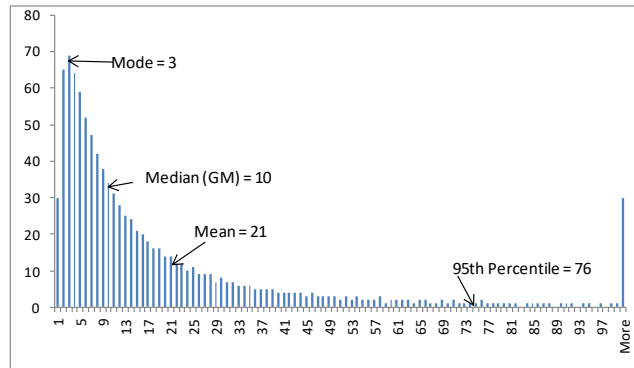
Parametric Methods for Lognormal Data

Line Fit Plot

Ln(8-Hr TWA)

Standard Normal - z

- **Minimum Variance Unbiased Estimator (MVUE)** is the best method for complete data sets with between 6 and 15 results

- **Maximum likelihood estimation (MLE)** is considered the best method for large sample size (n > 15) data sets in which at least 25% of the data are detected.

- **Bayesian inference** has come into increasing use for small sample size (n < 15) complete or censored data sets.

- **Least squares regression (LSR)** is supported by MS Excel. It also called linear or log-probit regression. It is a method for large sample size (n > 15) and at least 25% detected results.

6

Nonparametric Methods

PLE for Millwright With 90 Percent CLS
95th Percentile= 11.3 (6.676,13.777)
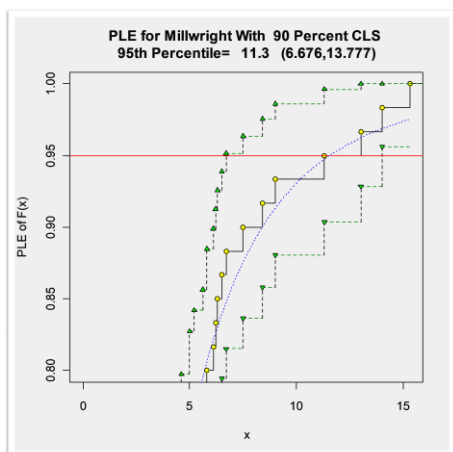
- **Kaplan-Meier Product Limit Estimator (PLE)** is the best method for estimating 95-95 UTL for complete or censored continuous data when n> 59 with at least 25% detected results.

- **Order Statistics and the Binomial Distribution** provide methods for estimating a 95-95 UTL and percent exceeding when n > 59, even if there are no detected results. MS Excel BINOM.INV function.

- **Quasi-Nonparametric Upper Tolerance Limits (QNP-UTL)** provide methods for estimating confidence intervals for data sets with 8 to 59 results that are all or nearly all censored.

7

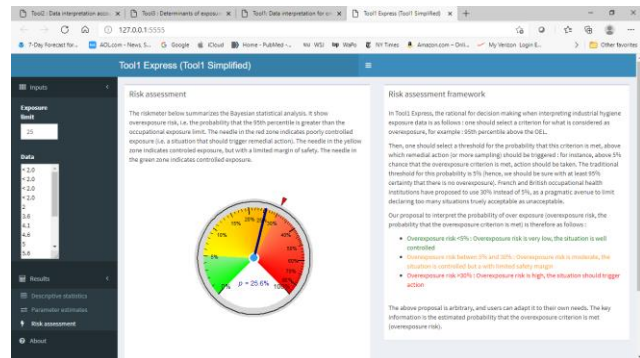## IH Apps & Tools | AIHA
IHSTAT –Spreadsheet

- Free download at https://www.aiha.org/public-resources/consumer-resources/topics-of-interest/ih-apps-tools

- Provides MVUE and non-parametric estimates for percent exceeding and the upper tolerance limit.

- Requires complete data (no non-detects)

8

4

AIHA
UNIVERSITY.
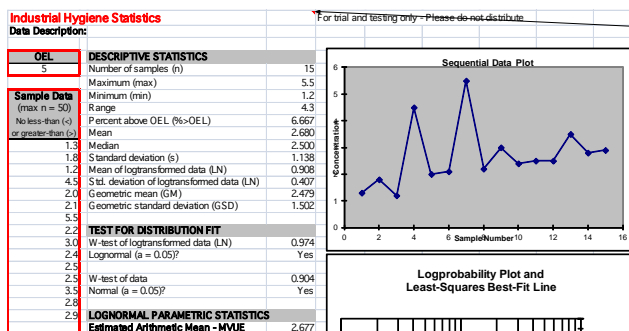
Expostats - Statistical tools for the interpretation of industrial hygiene data

- Free download at https://expostats.ca/site/en/index.html or can be run on the hosts computer

- R-project open source, free software

- Bayesian inference, accommodates almost any parametric data.

9

AIHA
UNIVERSITY.

OSHA Chemical Exposure Health Data (CEHD)
https://www.osha.gov/opengov/healthsamples.html

UNITED STATES DEPARTMENT OF LABOR

Occupational Safety and Health Administration

CONTACT US   FAQ   A TO Z INDEX   ENGLISH   ESP.

OSHA ⌄   STANDARDS ⌄   ENFORCEMENT   TOPICS ⌄   HELP AND RESOURCES ⌄   NEWS ⌄   🔍 SEARCH OSHA

Data & Statistics / Chemical Exposure Health Data

Chemical Exposure Health Data

OSHA compliance officers often take industrial hygiene samples when monitoring worker exposures to chemical hazards. Many of these samples are submitted to the Salt Lake Technical Center (SLTC) for analysis. The sampling results included on this web page represent the records of the SLTC sampling information system from 1984 forward. They include data on personal, area, and bulk samples for various airborne contaminants. All inspection sampling results will be included here once the case is closed. OSHA does not publicly disclose information from the following types of cases: open inspections and citations currently under contest or under appeal to the Occupational Safety and Health Review Commission or the U.S. Courts of Appeals. After litigation has concluded, the sampling data from the related inspection will be added at the next scheduled update. OSHA updates the data on this web page semi-annually in January and July.
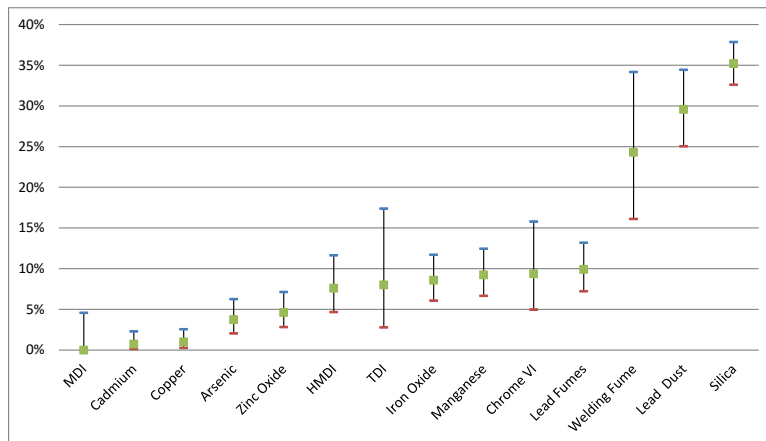
2/25/2022

10

Slide 11

AIHA UNIVERSITY.

CEHD for Construction 2014 – 2018
Percent Exceeding and 95% Upper and Lower Confidence Limits

- Roll-up of results from hundreds of compliance inspections

- Binomial estimates of confidence intervals

- Percent exceeding metric eliminates units to facilitate presenting data for different agents on the same chart

https://www.osha.gov/opengov/healthsamples.html

11

Slide 12

AIHA UNIVERSITY.

Compliance Officer Manganese Exposure Monitoring Results 2013-2017
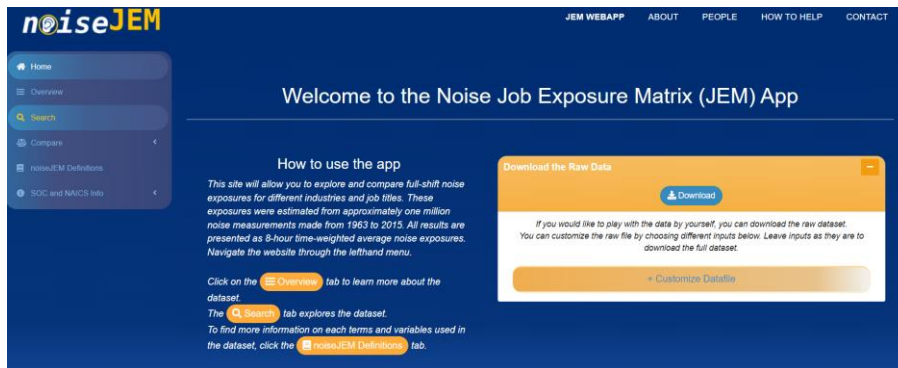
	Value	Units
ACGIH TLV for Inhalable Mn	0.1	mg/m^3
ACGIH TLV for Respirable Mn	0.02	mg/m^3
Observed 95th Percentile	0.252	mg/m^3
Upper Tolerance Limit of the 95th %ile	0.437	mg/m^3
Maximum	1.876	mg/m^3
Percent Non-Detects	50.5	%
Number of Results	406	
Detected Results	201	
Percent Exceeding 0.1 mg/m3	11.1	%
Lower Confidencee Limit	8.6	%
Upper Confidence Limit	14.0	%

- OSHA compliance officers self monitor.

- These results are the Mn component of welding fume

- Do standby workers need respiratory protection?

- Are far field sources a significant contributor to welders' exposure?

- Resuspension of settled dust?

- Should we be using respirable dust monitors for welding fume?

- Maybe wear a respirator next time you evaluate a welding shop.

2/25/2022

12

AIHA
UNIVERSITY.

University of Michigan US – Canada Noise Job Exposure Matrix
https://noise-jem.shinyapps.io/NoiseJEM/ (accessed 02/15/2022)

AIHA
UNIVERSITY.

First-Line Supervisors of Construction Trades and Extraction Workers
Standard Occupation Code 47-1010

Excel Functions
F8 = 1800

| Non-Parametric Estimates		
# Monitoring Results	1800	
Rank of 95th Percentile	1711	
95th Percentile	87.6	dBA
Rank of 95-95 UTL	1726	
95-95 UTL	87.9	dBA
Noise Reduction Rating	2.90	
Number Exceeding 85 dBA	210	
Percent Exceeding 85 dBA	11.7%	
Binomial 95% LCL	10.4%	
Binomial 95% UCL	12.9%	

- =ROUNDUP((F8+1)*0.95,0)

- =LOOKUP(F33,A21:A1801,C21:C1060)

- =BINOM.INV(F8+1,0.95,0.95)

- =LOOKUP(F35,A2:A1801,C2:C1801)

- =COUNTIF(C2:C1801,">85")

- =F38/F8

- =BINOM.INV(F8,F39,0.05)/F8

- =BINOM.INV(F8,F39,0.95)/F8

AIHA
UNIVERSITY.

Respirable Silica 8-Hr TWA Exposures

- 60 exposure monitoring results from a crew removing old and installing new process equipment.

- Broken-out by tool used

- Estimates of the 95th percentile (yellow squares) are below the OEL

- Uncertainty is high for 3 tools

- Rotary hammers are the best opportunity for improvement

15

AIHA
UNIVERSITY.
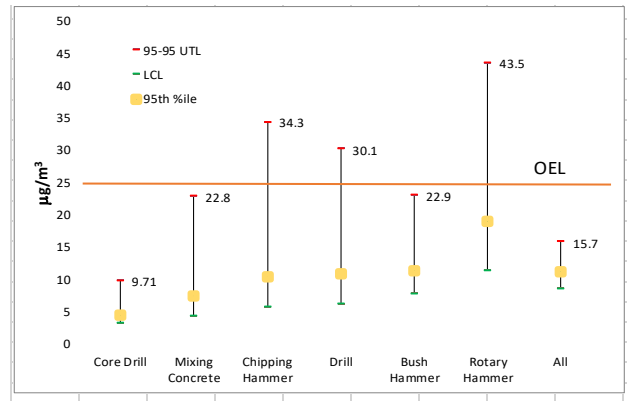
Questions

Paul Wambach

Email: PFWambach@verizon.net

Phone: 240-644-7081

2/25/2022   16