PRACTICE GOOD *INDUSTRIAL* HYGIENE

AUGUST 2026

THE STATISTICS OF EXPOSURE RISK

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:

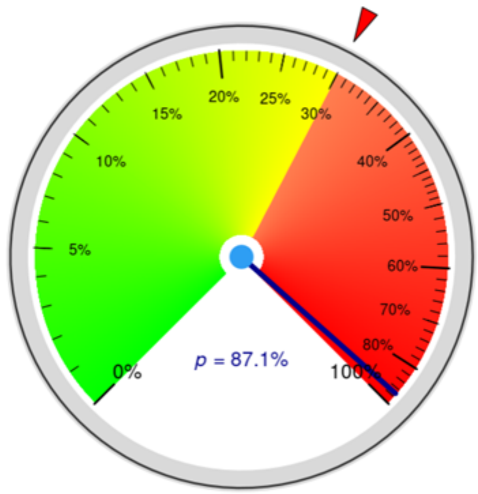
  87.1 %

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

  < 30%

- As a consequence, the current situation is declared:

  Poorly controlled



In the world of data analytics, information is mined from various sources and gathered into meticulous piles to be organized, categorized, and synthesized into digestible formats for target audiences. Industrial Hygiene (IH) investigations are themselves a goldmine of raw data waiting to be digested. Many workplaces have years of past IH exposure monitoring data that can be used to make informed exposure assessment decisions, provided that statistical tools are utilized properly.

Many statistical analysis tools with training are available free of charge and readily accessible through industry groups such as the American Industrial Hygiene Association (AIHA). These tools utilize Bayesian statistical techniques to analyze trends in exposure monitoring data. Using this approach, exposure categories are assigned to the sample set based on the exposure results for each relevant Similar Exposure Group (SEG) using a defined decision statistic (e.g., the 95th percentile). This enables the Industrial Hygienist to determine the probability that the true 95th percentile of the exposure results would fall within one of the AIHA Exposure Rating Categories, which range from 0 (<1% of the Occupational Exposure Limit) to 4 (>100% of the OEL), where 0 represents a negligible exposure, and 4 represents a poorly controlled exposure. A confidence rating is also assigned to these results.

Looking at industrial hygiene data this way can tell us several things in a short time. By looking at the distribution, we can assess whether the chosen similar exposure groups (SEGs) were properly selected. We can tell whether the sampling rates are at the correct frequency and whether the sample sizes are adequate.

While Bayesian tools are great for statistical analysis, there are ways to take the data a step further. This is also true for any additional information that may be paired with quantitative results. Risk rankings, qualitative analysis, prevention through design, and audit findings, to name a few. The numeric output of any of these assessments can be placed into a visual data analytics tool to help drive decision-making and impact stakeholders.

It is important to ensure that your data is sound and your metrics are consistent across multiple collection events. The adage “garbage in equals garbage out” applies here and comes up very often in topical conversations. If establishing a new program, align on terms, units of measurement, and other similar parameters at the start. For seasoned programs, it is not too late to create a reference or dictionary. Once you have alignment, you can establish connections to form a total picture of true exposure risks and drive informed decision-making.

Modeling asbestos exposure data utilizing the Expo Stats Tool 1: Estimation of parameters of the lognormal distribution and comparison to an occupational exposure limit (OEL) can give a clearer picture as to the exposure risk for each of the following SEGs:

- SEG 1 - Gross removal of friable asbestos TSI from a pipe within a containment utilizing wet methods.
- SEG 2 - Performing fine cleaning following gross removal of asbestos TSI.

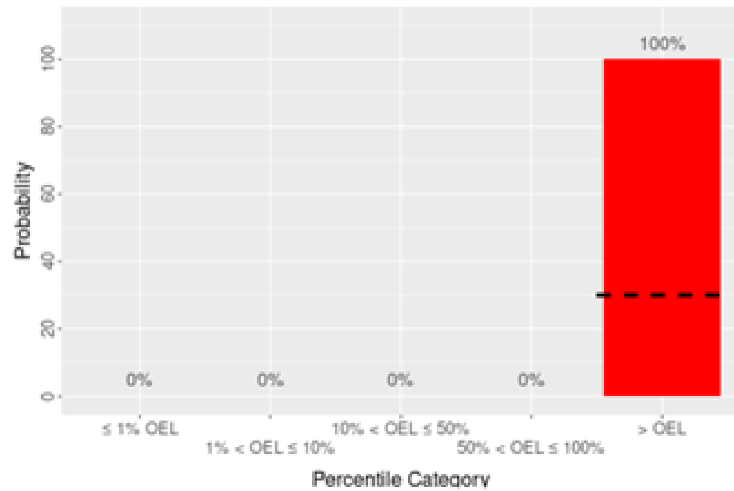
For this example, we will use mock personal air sampling results generated with industry knowledge and assume the data were collected over three separate projects, using the same five employees for gross removal and five employees for fine cleaning. Each SEG will have fifteen (15) data points presented as an 8-hour time-weighted average (TWA), and we will compare it to the Occupational Health and Safety Administration (OSHA) Permissible Exposure Limit (PEL) of 0.1 f/cc. The samples will have theoretically been analyzed via NIOSH Method 7400 phase contrast microscopy (PCM). Below are the statistics for each data set, presented numerically and graphically on the Risk Band Plot.

SEG 1

Descriptive Statistics

Sample Statistic	Value
Number of Obversations	15
Proportion Censored	0
Minimum	0.15
25th Percentile	0.23
Median	0.29
75th Percentile	0.33
Maximum	0.42
Proportion Greater than OEL	100%
Arithmetic Mean	0.28
Arithmetic Standard Deviation	0.0822
Coefficient of Variation	29.4%
Geometric Mean	0.268
Geometric Standard Deviation	1.38

Risk Band Plot



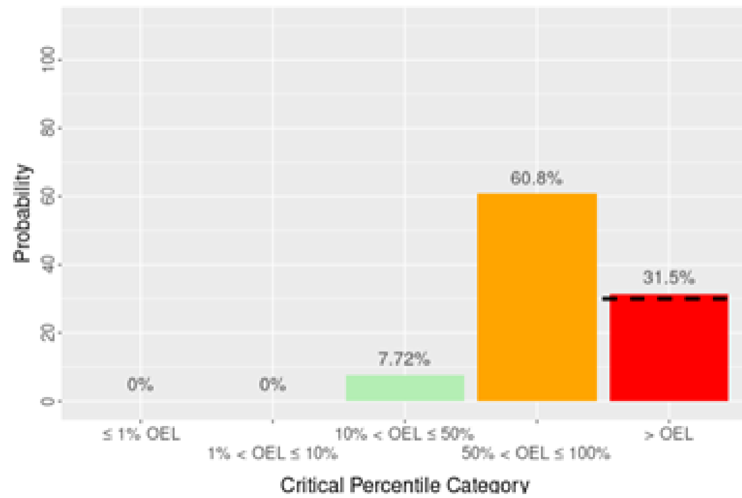
This plot shows the probability distribution of the uncertainty around the 95th percentile. It shows the probability that its true value is (1) below 1% of the OEL, (2) between 1% and 10% of the OEL, (3) between 10% and 50% of the OEL, (4) between 50% and 100% of the OEL, and (5) greater than the OEL. This is based on the classification adopted by AIHA. The red column represents the probability of an overexposure. The latter should be lower than the threshold (black dashed line).

SEG 2

Descriptive Statistics

Sample Statistic	Value
Number of Obversations	15
Proportion Censored	0
Minimum	0.002
25th Percentile	0.009
Median	0.012
75th Percentile	0.035
Maximum	0.08
Proportion Greater than OEL	0%
Arithmetic Mean	0.0245
Arithmetic Standard Deviation	0.025
Coefficient of Variation	102%
Geometric Mean	0.0155
Geometric Standard Deviation	2.74

Risk Band Plot



This plot shows the probability distribution of the uncertainty around the selected percentile. It shows the probability that its true value is (1) below 1% of the OEL, (2) between 1% and 10% of the OEL, (3) between 10% and 50% of the OEL, (4) between 50% and 100% of the OEL, and (5) greater than the OEL. This is based on the classification adopted by AIHA. The red column represents the probability of an overexposure. The latter should be lower than the threshold (black dashed line).

Using this data, we can better predict the likelihood of personal exposure to airborne asbestos fibers during these two specific work activities. This, in turn, helps determine the proper level of personal protective equipment (PPE), as well as other risk-reduction strategies such as engineering controls that may be used during abatement efforts. We can see from our specific examples that gross removal presents the highest risk of exposure above the PEL, and while fine cleaning following the gross removal presents a lower risk, it still has the potential to exceed the PEL. If we took this a step further and used data from an abatement project where wet methods were not utilized, we could really dig into just how statistically effective those methods are at reducing the exposure risk to airborne fibers.

Our example includes two very different results for the coefficient of variation showing the spread of our data. Results for SEG 1 have a smaller variation than SEG 2, which shows that the work practices in SEG 1 resulted in more consistent results. For our purposes, this may mean that SEG 2 includes additional sub-SEGs, such as workers performing scrubbing and HEPA vacuuming, while others are only removing waste bags, or perhaps the engineering practices were very different from job to job. It is easy to see from this example how having a smaller data set or adding SEGs with dissimilar work practices could easily skew our results and lead to an incorrect analysis of the risk. It is crucial that data sets, combined with a proper understanding of the SEGs, be utilized to continuously improve work practices.

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