

Improving Exposure Judgments: Making the Case for Good Practice in Consulting

For your clients. For their workers. For you.

The Quality of Exposure Judgements is a Significant Issue for Businesses and their Workers

At its core, the purpose of Industrial Hygiene/Occupational Hygiene (IH/OH) consulting is to provide expert advice and strategic guidance that helps organizations protect workers, ensure regulatory compliance, and enhance efficiency and productivity.

Employers who retain IH/OH consultants to assess workplace exposure risks rely on their expertise, skill and professional judgement. By following professional good practice, IH/OH consultants can provide clients with services and advice using a systematic and science-based approach which facilitates confidence in exposure judgments. Accurate exposure judgments enable appropriate and cost-effective risk management actions to ensure that workers are protected from health hazards, that the business is in conformance with IH/OH regulations and internal standards, and that the business is not disrupted due to issues associated with worker health concerns or legal liability. Conversely, errors in exposure judgements can result in insufficient risk management activities that fail to protect workers, unnecessary costs, regulatory noncompliance, business disruptions, and other impacts on businesses.

For these reasons – and because building consulting practices depends on relationships based on trust and credibility - integrating proven, practical strategies for improving the quality of exposure judgements into consulting processes and workflows is important for IH/OH consultants, their clients and their workers.

Exposure Judgements can be Improved by Simple Measures

The quality of professional judgements is a concern in many fields, including law, medicine, engineering, statistics, business disciplines and human resources. Measures shown to improve judgements include: use of a structured approach; deliberate and systematic decision-making; documentation of observations; use of algorithms and checklists; considering diverse perspectives; and using feedback to calibrate judgements¹.

In the field of IH/OH, research has shown that exposure judgements made without using a structured, science-based approach are often highly subjective, frequently incorrect, and tend to underestimate worker exposures^{2,3,4}. IH/OH professionals presented with the same information often disagree for multiple reasons, leading to practitioners arriving at different judgements using the same information. All of these scenarios are of concern and may negatively impact consultants, their clients, workers and/or the public. As in other fields, a structured approach and the use of simple tools such as decision algorithms,

models, and statistical tools have been shown to significantly and reliably improve the quality of exposure judgements made by IH/OH professionals^{2,3,4}.

Using Structured Exposure Assessment Strategy and Tools Benefits Consultants and Clients

AIHA's Strategy for Assessing and Managing Occupational Exposures^{5,6} (AIHA Strategy) provides a blueprint for implementing a structured, science-based approach to improving exposure judgement accuracy into any organization. In addition to enhanced worker protection, regulatory compliance, efficient use of resources, and business continuity, Implementing the AIHA Strategy benefits both consultants and their clients:

- **IH/OH Consultants**
 - Provides a framework for engaging, informing, and educating employers/clients.
 - The continuous improvement approach is systematic, stepwise, iterative, and scalable.
 - It can be adapted for different organizations, contexts, and problems.
 - Provides a rational basis for proposed activities and deliverables.
 - Avoids over-reliance on subjective professional judgement.
 - Increases confidence in results / conclusions / recommendations.
 - Provides a best practice approach to offering exposure assessment-related services.
 - Demonstrates competence in exposure assessment as a differentiator.
- **Clients**
 - Fills gaps in outdated or incomplete regulatory guidance.
 - Demonstrates a 'best practice' approach to achieving worker protection and compliance.
 - Readily integrates into management system standards.
 - Facilitates assessment of consultant qualifications and capabilities.
 - Provides a basis for defining consultant performance expectations.
 - Promotes transparency / accountability on the part of consultants.
 - Facilitates practical understanding of IH/OH concepts/terms/requirements.
 - The stepwise, scalable and flexible approach supports cost control.
 - Emphasizes context-specific results and data quality.

Integrating Exposure Assessment into Consulting Processes and Workflows

The AIHA Strategy provides a proven, logical step-by-step workflow that streamlines proposal planning, communication, implementation, and reporting. It increases confidence for both clients and consultants in the value of money spent and the outcomes achieved - while providing a solid baseline for future work.

Integrating the AIHA Strategy into consulting processes and workflows is straightforward and supports developing scopes of work which include specific exposure assessment activities and deliverables. For example:

- Starting with the first contact with a potential client, information on the exposure context, the specific exposure problem(s) to be addressed and information that would typically be collected as part of the AIHA Strategy basic characterization step can be collected.
- If a virtual or live meeting is held to support development of a proposal, an overview of the AIHA Strategy can be used to explain key IH/OH terms and concepts and to collect additional information on facilities, processes, machinery and equipment and work organization. This information can then be used to similar exposure groups (SEGs), develop a sampling strategy, and identify deliverables.
- Visiting a facility or work location and performing a walkthrough of the areas and work activities to be assessed can be invaluable for confirming information provided by the client and provide insights that can be addressed in a proposal.
- The proposal can reference the AIHA Strategy to provide a rationale for the steps to be taken, the types of monitoring and/or sampling to be conducted, and the numbers of samples to be collected. The importance of data analysis using accepted statistical tools should be noted and the manner in which results will be interpreted and presented explained in simple terms.

Making the Case for a Good Practice Approach to Exposure Assessment

IH/OH consultants often face unique demands and constraints that can complicate decision-making. Convincing clients of the importance and benefits of aligning the scope of work with IH/OH exposure assessment good practice to ensure accurate exposure judgements and effective risk management is critically important. Following are talking points that will help make the case.

Protect People

A systematic, science-based approach to exposure assessment ensures accurate exposure decisions that enable the development of appropriate risk management options to ensure that people working at the client's facilities are protected from health hazards. Past approaches, heavily reliant on subjective professional judgments and interpretation of monitoring data without the use of statistical tools, have been shown to be prone to errors^{2,3,4}. This results in poor risk management decisions that waste money on unneeded controls or leave people overexposed to health hazards.

Ensure Compliance

Businesses are required to comply with regulatory requirements, not just on some days, but every day. Using a science-based approach to exposure assessment and the statistical analysis of exposure measurement data ensures that the business is in compliance not only on days when workers exposures were measured, but also on days when they were not measured as well.

Protect the Business

Disruptions in business continuity, loss of brand reputation, and legal liabilities can all be caused by insufficient management of worker exposure risks and compliance - resulting in huge costs to the business. Using a systematic, science-based approach to exposure assessment ensures accurate exposure decisions that enable appropriate risk management decisions to keep workers safe and help ensure business continuity, brand reputation, and minimize legal liabilities.

Understand and Manage Variability

Businesses understand the importance of process understanding and quality control. They are well versed in techniques for quality control sampling and statistical analysis to understand and manage process variability. Just as production processes are variable, so too are worker exposures. Using statistical tools to interpret monitoring results leads to an understanding of exposure variability and enables accurate exposure decisions that account for the uncertainty introduced by the fact that very few of the workers' exposures are actually measured. Just as a robust quality control program ensures that products are produced to specification, a robust approach to exposure data interpretation ensures that worker exposures are within acceptable levels.

Systematic Process

Businesses benefit by having systematic and transparent business and production processes that lend themselves to process understanding, control, and improvement. Applying a structured, science-based approach to exposure assessment and management provides the same benefits, including data-driven decisions, a fuller understanding of exposures, and systematic approaches to risk prioritization.

Management System

Management systems are frequently used by businesses to document, communicate, and administer their business processes. A systematic, structured approach to exposure assessment and management^{5,6} can easily be incorporated into management systems, including an OEHS Management System⁷.

Continuous Improvement

Few businesses have the resources to immediately implement every improvement opportunity. They must therefore rely on a prioritized continuous improvement process. Implementing a robust exposure assessment and management process is also a continuous improvement journey. Facilitating this journey are robust approaches to prioritization and planning that are key aspects of the process⁵.

Additional Benefits

A science-based approach to exposure decision making offers solutions to these specific client issues:

- The transparent, structured approach facilitates engagement, communications and problem solving with others inside and outside of the organization (e.g. Operations, Engineering, Purchasing, etc.)
- Provides clients with a defensible rationale for numbers of samples^{5,8}.
- Enables sound judgements based on very small numbers of samples – including sets with sample sizes as low as one.

- Analysis of sampling results which are below the limit of detection.
- Verifiable data to inform and validate previous exposure judgements.
- Analysis of historical exposure data to make comparisons and identify trends.
- Increased confidence in respirator selection and the performance of other control systems.
- Effective communication of exposure risks to clients
- Client risk management and business decisions regarding controls and future assessments

I Am Not an Expert on Statistics – How Easy Are These Exposure Assessment Resources to Use?

You don't need to be an expert in statistics to use the AIHA e-tools and other resources successfully. AIHA gives you all the training and tools you need:

- The free Occupational Exposure Assessment [Principles of Good Practice](#) provide a concise listing of risk critical practices for effective and efficient exposure assessment and management.
- The free nine-hour online course, "[Making Accurate Exposure Risk Decisions](#)", gives you the basics of using statistical analysis in your exposure assessments.
- You can access and use the [AIHA's free software e-tools](#) to efficiently characterize exposures in just minutes.
- The free [Exposure Decision Analysis Registry](#) (EDA) program, enhanced by the free EDA prep course, Making Accurate Exposure Risk Decisions, and validated through the EDA Competency Assessment, has revolutionized the way the IH/OH community approaches statistical analysis and making informed decisions about worker exposure and exposure uncertainty.

Suggested Proposal / Contract Language

Following is language that may be helpful when drafting a consulting proposal or contract.

Exposure Risk Assessment and Management Process

Our exposure risk assessment process is based on IH/OH good practice described in two standard references: the American Industrial Hygiene Association's (AIHA's) *A Strategy for Assessing and Managing Occupational Exposures* (4th edition)⁵; and the AIHA Guideline Foundation's *Occupational Exposure Assessment Principles of Good Practice*.⁶

Similar to the Plan, Do, Check, Act (PDCA) cycle as implemented within the ISO 45001: 2018 OHS management systems standard⁷, the AIHA exposure assessment strategy is intended to be used in an iterative manner to support continuous improvement and is both effective and efficient. Effective means ensuring that no worker has unacceptable exposures and that the organization is in compliance with relevant regulatory requirements. Efficient means doing so while minimizing the cost.

Initial assessments are used to collect information and data that is relatively easy to obtain. More detailed assessments and exposure measurements are then conducted as required to refine priorities,

accurately define worker exposure profiles, and facilitate exposure judgements and effective risk management.

The AIHA strategy rates exposures into five Exposure Rating Categories relative to the Occupational Exposure Limit (OEL) as presented in Table 1. Recommended risk management controls are associated with each category.

All exposure measurements are analyzed using IH/OH statistics. Exposures are deemed unacceptable and out of compliance when there is a greater than 30% likelihood that the exposure is above the OEL (i.e. category 4: >100 % of the OEL).

More detail regarding the AIHA Strategy can be found in Appendix A

Table 1 – AIHA Exposure Rating and Control Categories

	Exposure Rating Category**	Recommended Control
	0 (<1% of OEL)	No action
	1 (<10% of OEL)	Procedures and Training; General 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)	+ Implement Hierarchy of Controls; Monitoring to Validate Respirator Protection Factor Selection.

** Decision Statistic = 95th Percentile

References

1. Kahneman, D.: Thinking, Fast and Slow. New York: Straus and Giroux, 2011.
2. Logan, P., Ramachandran, G., Mulhausen, J., & Hewett, P. (2009). Occupational exposure decisions: can limited data interpretation training help improve accuracy? Annals of occupational hygiene, 53(4), 311-324.
3. Vadali, M., G. Ramachandran, J. Mulhausen, and S. Banerjee: Effect of Training on Exposure Judgment Accuracy of Industrial Hygienist. J. Occup. Environ. Hyg. 9(4):242–56 (2012).
4. Arnold, S.F., M. Stenzel, D. Drolet, and G. Ramachandran. Using checklists and algorithms to improve qualitative exposure judgment accuracy, J Occup Environ Hyg. Vol 13. Issue 3. p 159-168. 2016.

5. "A Strategy for Assessing and Managing Occupational Exposures. 4th Ed." AIHA Press. 2015.
6. [Principles of Good Practice: Exposure Assessment Strategies. AIHA Guideline Foundation.](#)
7. ISO 45001:2018 Occupational health and safety management systems
8. [IHSTAT® macro-free v2.0](#)

Useful Resources

- **American Industrial Hygiene Association (AIHA)**
"A Strategy for Assessing and Managing Occupational Exposures. 4th Ed." AIHA Press. 2015.
[AIHA Exposure Risk Assessment & Management Tools](#)
[Member Ethical Principles](#)
[Principles of Good Practice](#)
[Exposure Decision Analysis Registry](#)
[The Meaning of "Good Practice" - Integrating the Technical and Business Aspects of Occupational Hygiene - BY TOBIAS STEELE](#)
Free Online Webinar "[Making Accurate Exposure Risk Decisions](#)"
- **American Conference of Governmental Hygienists (ACGIH)**
[Member Ethical Principles](#)
- **British Occupational Hygiene Society (BOHS)**
[Code of Ethics](#)
[Good Practice Guide for Consultants](#)
[Buyers Guide for OH Services](#)
[Testing Compliance with Occupational Exposure Limits for Airborne Substances](#)
- **Government of Alberta, Canada**
[GS009: Tips on selecting an OHS Consultant](#)
[GS019: Occupational hygiene reports: requirements and tips](#)
[GS020: Occupational Hygiene Competency](#)
- **European Union**
[CEN 689 2018](#)

- **Board for Global EHS Credentialing (BGC)**

[Code of Ethics](#)

- **Expostats Website**

[Expostats](#)

Appendix A

Summary of Some Key Aspects of AIHA's Strategy for Assessing and Managing Occupational Exposures

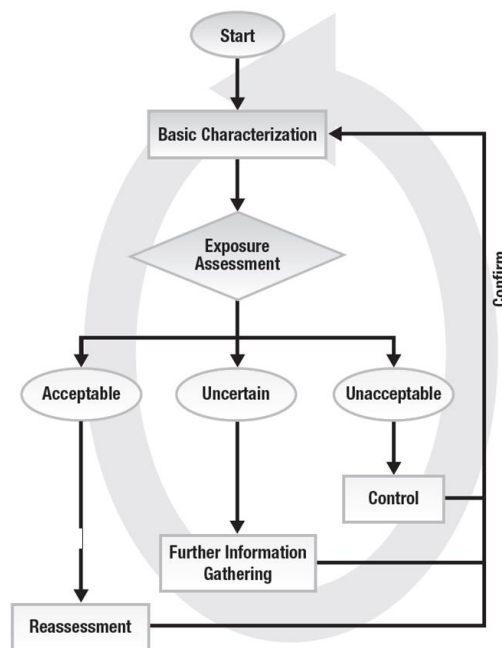
Primary goals of exposure assessment include accurate and efficient exposure decisions which support efficient and effective risk management. Efficient means minimizing the cost of assessment. Effective means ensuring that no worker has unacceptable exposures.

Figure 1 – Exposure Risk Management Strategy

Well-Designed Exposure Risk Management Strategy	
We Want:	We Don't Want:
Good Data	Bad Data
To Be Effective	To Not Be Protective
To Be Efficient	To Waste Resources
No Biases	Biases (High or Low)
Low Uncertainty	High Uncertainty
Correct Decisions	Wrong Decisions

Similar to the Plan, Do, Check, Act (PDCA) cycle as implemented within the ISO 45001: 2018 Occupational Health and Safety systems standard, the American Industrial Hygiene Association's (AIHA's) exposure management strategy (Figure 2) is cyclic and is intended to be used in an iterative manner with an emphasis on incremental and continuous improvement.

Figure 2 – AIHA Exposure Assessment Strategy



To achieve the primary goals identified above, accurate estimates of exposure and indications of the level of confidence in exposure estimates are required.

The two primary challenges to achieving these goals are exposure variability and the fact that collecting large numbers of samples is often not practicable, so that exposure judgements and risk management decisions are often made based on limited data.

For example, in a year (250 working days), if a worker is exposed daily and 5 samples are collected, only 2% of the total number of exposures have been assessed. In addition, studies have shown that studies have shown that qualitative and quantitative exposure judgments by even experienced practitioners are often wrong and tend to underestimate exposure risks. Training and the routine use of statistical tools to interpret data can significantly improve exposure judgements,

For these reasons and as in other fields, including engineering, healthcare, research, environmental science, business and government, where statistics provide essential frameworks for informed decision making, good IH practice emphasizes incorporating statistical considerations into the exposure assessment process and the use of statistical tools and algorithms to support and validate professional judgements.

The aim is to have high confidence that no more than 5% of exposures experienced by a worker or a similarly exposed group (SEG) of workers exceed an OEL. In statistical terms, this is achieved by maintaining the 95th percentile of the exposures associated with a job or task below the OEL with a specified level of confidence. Confidence levels are essential for the proper use of statistical methods because they are an indication of the reliability of the estimate of the 95th percentile. The aim is to be at least 70% and ideally 95% certain that the 95th percentile estimate can be relied on.

To achieve these aims: (1) the exposure question must be well described; (2) the (groups of) workers to be assessed must be well defined; (3) the appropriate OELs must be identified; (4) an appropriate sampling strategy including an appropriate number of samples must be developed; (5) a valid and appropriate monitoring method must be used; (6) a valid analytical method must be used, and (7) appropriate statistical approaches, tools and algorithms must be used to analyze data and to facilitate exposure judgements and risk management decisions.

In the AIHA exposure assessment strategy, the 95th percentile is used to determine whether an exposure profile is acceptable and to assign an Exposure Rating Category (Figure 3). Use of the exposure rating categories avoids diminishing returns from over-refining exposure estimates, streamlines documentation, facilitates Qualitative Exposure Assessments (QEAs) and drives consistent follow up management and control activities which lead to consistent risk management,

Figure 3 – AIHA Exposure Rating and Control Categories

Exposure Rating Category**	Recommended Control
0 (<1% of OEL)	No action
1 (<10% of OEL)	Procedures and Training; General 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)	+ Implement Hierarchy of Controls; Monitoring to Validate Respirator Protection Factor Selection.
Multiples of OEL (>500% of OEL or others based on respirator APF)	+Immediate Engineering Controls or Process Shut Down, Validate Acceptable Respirators

** Decision statistic = 95th percentile

Exposures are judged acceptable if the estimated 95th percentile for an SEG exposure profile is less than the OEL with at least 70% confidence. Additional monitoring, as part of continuous improvement, is recommended to increase the confidence level to 95% for SEGs with exposures in Exposure Categories 2 (10 – 50% OEL) and 3 (50 – 100% OEL).

In addition, the level of confidence associated with the 95th percentile for each exposure assessment can be rated (high, medium, or low). For initial (e.g. “screening”) assessments, ratings may be based on qualitative criteria. When monitoring data are available, quantitative criteria based on statistics can be used and statistical software used to confirm whether criteria are met.

As indicated above, the AIHA exposure assessment strategy is cyclic and intended to be used in an iterative manner with an emphasis on incremental and continuous improvement. It is an example of accepted IH good practice which has been used worldwide in to protect workers, improve and validate exposure management and generate value or industry and other organizations.