Developing a Pragmatic Approach to Occupational Health Risk Assessment Monitoring

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Abstract

Over the years the approach to hygiene monitoring has been largely based on the assumption of homogeneous similar exposure groups (SEGs). As workers multi-skill, SEGs are becoming more diverse and the monitoring data increasingly larger. This in turn is leading to high levels of variation in the data. Is too much time now being spent sampling to achieve better uniformity to meet perceived compliance requirements or is there a more pragmatic approach that can re-focus the hygienists time back to field assessments and control management rather than data collection?

Introduction

A key component of many hazardous exposure management programs is the measurement of personal exposure profiles. This reflects the increased emphasis on compliance to exposure limits by Regulators. Since 2012 most Australian states and territories have been implementing the model Work Health and Safety (WHS) Act and Regulations (SWA, 2020), to harmonise work health and safety law in Australia. Of importance to discussion in this paper is Chapter 3, Division 7 of the WHS Regulations; *Managing risks from airborne contaminants*:

- Clause 49: *Ensuring exposure standards for substances and mixtures not exceeded*.
- Clause 50: *Monitoring airborne contaminant levels*.

Through these Regulations, the occupational exposure limit (OEL), termed the workplace exposure standard (WES) for airborne contaminants, has gained legal status. Regulatory organisations expect that a comparison of workplace exposures with published WESs can be used as a means of judging compliance with the law. Of course, our prime aim should be to protect the health of workers, ensuring that exposures to hazardous agents are as low as reasonably practicable.

It should be noted that clause 50 requires the airborne concentration of a hazardous chemical to be monitored by persons conducting businesses or undertakings (PCBU) in only two instances:

a) if the person is not certain on reasonable grounds whether or not the airborne concentration of the substance or mixture at the workplace exceeds the relevant exposure standard; or
b) if monitoring is necessary to determine whether there is a risk to health.

Airborne monitoring of contaminants hazardous to health is not always required. Air monitoring can be either periodic or continuous and is the quantitative **or qualitative** assessment of the extent of pollutants in or around the workplace. It is used to ensure compliance with appropriate legislation and to evaluate control measures that either eliminate or minimise hazardous exposure.

Where there is uncertainty as to exposure, where it is at all practical to do so, or decisions cannot be made without it, monitoring should be pursued. This raises the question as to whether this is actually how it is being applied in workplaces, or has monitoring become so entrenched that it is a crutch used by both the Regulator and the regulated.

The authors are concerned that two key issues may arise:

1. Irrespective of the claim of some that complex sophisticated sampling and statistical models are needed; such elaborate monitoring programs are likely to be beyond the resources of small to medium businesses. These will remain the province only of large corporations, regulatory authorities or those conducting research programs.
2. Even though some large businesses have the resources to conduct large scale workplace monitoring, too much effort is being put into such monitoring. This additional effort needs to be focused on alternative approaches to identifying higher level controls and ensuring the efficacy of those controls for managing risk of adverse health exposures.

Risk Assessment

Any sampling program should be part of a planned approach, based on risk assessment. While risk assessment is not specifically identified in the WHS Regulations, clause 34 requires the PCBU to "identify reasonably foreseeable hazards that could give rise to risks to health and safety". More detail on hazard identification and risk assessment can be found in the AIOH publication '*Simplified Occupational Hygiene Risk Management Strategies*' (Firth et al, 2020) and the SWA (2018) publications *Model Code of Practice - Managing Risks of Hazardous Chemicals in the Workplace* and *Managing risks of hazardous chemicals in the workplace*.

These documents note that if, after identifying a hazard, you already know the risk and how to control it effectively, you should simply record the result of the risk assessment and implement the controls. Workplace monitoring in this instance should only occur if it is necessary to demonstrate the success of the implemented controls.

The outcome of the occupational health risk management process (Firth et al, 2020) should be the prioritisation of potential health risks in order to facilitate the drafting of:

- An action plan to cost-effectively eliminate or reduce adverse exposures; and
- Occupational hygiene and medical surveillance monitoring programs, where required.

Traditional Data Collection and Assessment

The AIOH publication '*Occupational Hygiene Monitoring and Compliance Strategies*' (Grantham & Firth, 2014) details the traditional approach to exposure data collection and assessment for airborne contaminants and noise; occupational hygiene 'surveillance' monitoring. It describes:

- the factors influencing variability,
- the probability distribution that applies to most hygiene measurements,
- how to determine the number of measurements to make,
- statistical significance, and
- how to use the exposure standards to make valid risk assessments.

Particular importance is paid to the development of the similar exposure group (SEG), considered critical for making compliance decisions for both groups and individuals where economy in sampling effort is paramount.

The value in using a properly defined SEG lies in the ability to use data from a relatively small sample of a sub-set of the exposed population and be confident that you can predict the likely chronic health exposures of that sub-set of the population, which are not going to be influenced by different kinds of workers with other tasks in the whole workplace population (Grantham & Firth, 2014).

SEGs were at one time termed a homogenous exposure group (HEG), but the word 'homogenous' has since been replaced by 'similar', as it was recognised that workers in a group do not perform their tasks in an identical way. In addition, the trend to multi-skilling of the workforce has seen SEG exposures become more diverse with a consequent increase in data variability. However, as noted in Grantham and Firth (2014), it can be difficult to make decisions about work groups who rotate between multiple job types (and potentially SEGs) on a random basis within single shifts. Approaches for dealing with this include:

- assign the worker to the dominant SEG based on time spent or intensity of exposure; or
- group the workers that are being rotated into a higher level "generic group".

Generally speaking, for a lognormal distribution, a geometric standard deviation (GSD) of 1.5-2.5 is considered as acceptable. GSDs above 2.5 indicate moderate to high variability that can be a result of a poorly defined SEG. It may also be as a result of insufficient sample numbers, 'outlier' data (e.g. due to sampling errors), or a process that is not adequately controlled.

The greater the GSD of the measurements, the less sure we can be about what a few measurements really mean. Hence there is a tendency to collect large amounts of monitoring data, often driven by the NIOSH '*Occupational Exposure Sampling Strategy Manual*' (Leidel et al, 1977) guidance on sample number requirements. This may not always be necessary.

It is also important to note that there is often little need for further monitoring if there have been no major changes in processes, tasks, procedures, quantities and/or nature of substances encountered since the previous valid monitoring occurred.

Action Levels

With regard to data variability, it is perhaps appropriate to digress a little and discuss action levels, as discussed in Grantham and Firth (2014). Because we recognise that variability can occur, when adopting a compliance metric based on a mean or average it can be useful to know what is the chance that the true mean will at least be equal to the WES, even if our estimate is still below the WES. In other words, how close should you allow your exposure estimate get to the WES before you take some action to insure it does not exceed the WES?

Action levels are seldom specified in Australian State legislation. Likewise, SWA's Hazardous Chemical Information System (HCIS) and its documentation (SWA, 2013) contain no guidance on action levels. Legislation simply states absolute terms such as "no employee is exposed at levels above the appropriate exposure standards". Occupational hygiene practice traditionally sets an action level at 50% WES.

From a practical and cost benefit point of view, the action level gives a good pointer that it is better to spend resources on controls rather than on additional sampling to establish whether a workplace really complies or not.

However, Altree-Williams (1997), in comparing the GSD of a data set of 8-hour TWA values with an action level, noted that if the GSD is 1.7 or greater, the action level has to be below 0.5 x WES as there is a 95% chance of the true mean being no different from the WES. In other words, if a data set has a GSD greater than or equal to 1.7, then the application of an action limit is not appropriate, and emphasis should be on the 95% UCL or similar for chronic toxicants.

An Alternative Method for Exposure Assessment

EN 689 (2019) gives a strategy for testing compliance with OELs / WESs by measurement of exposure by inhalation to chemical agents. The strategy describes a procedure to perform a small number of exposure measurements to demonstrate with a high degree of confidence that workers are not likely to be exposed to concentrations higher than the WES, taking into account the variability of exposures.

As with the traditional approach, it focuses on groups of workers having similar exposure (SEGs). It comprises three main steps:

1. During the first step (basic characterisation), the appraiser collects available information to allow reliable estimates of the exposure of the workers and to take the decision whether or not to perform exposure measurements (essentially a risk assessment).
2. The second step (initial assessment), based on the testing procedure documented by BOHS-NVvA (2011), consists of performing at least three (screening test) to 6 representative exposure measurements for the workers of each SEG, in order to demonstrate by using a statistical test whether less than 5% of exposures in the SEG exceed the WES (i.e. compliance).
3. In a third step and based on the second step results, a program of periodic reassessment determines time intervals ranging from 1 to 3 years for performing new measurements, depending on the levels of exposure. This is based on the assumption that no major changes (e.g. process, quantities and nature of chemicals) have occurred during this period.

The BOHS-NVvA (2011) screening test (first measurement campaign) involves making three shift length exposure measurements from workers selected at random from the SEG. If all three results are < 0.1 WES, then the exposures of all members of the SEG can be taken to be less than the WES, and compliance is established, and no further measurements are required. The compliance is based on the probability that three random results all being so small come from a population for which the 95th percentile is below the WES. Compliance is established, the assessment is completed and a reassessment can be scheduled within the next 12 months, or earlier if a change is made to the process.

If any of the three measurements, all known to be valid, exceeds the WES then there will be non-compliance. The assessment is terminated and the exposure is to be controlled at the earliest opportunity.

Gravimetric versus Real-time

Over the years we have seen the technology in real-time sampling and monitoring develop rapidly yet its inclusion in the occupational hygienist's toolkit has been much slower. In the preface of AS2985-2009 it notes:

> *"During the course of the preparation of this Standard, the Committee became aware of new technology for personal respirable dust monitoring, using a tapered element oscillating microbalance technique, but it was decided not to address this issue at this time and to leave it for a future date."*

While it is a reference to a particular type of technology, it raises a number of questions. What is the current status in relation to the utilisation of real-time technology in general in this area? Can it be incorporated into an assessment program to characterise variable exposures more effectively? Will it reduce the reliance on the more resource intensive gravimetric approach?

While these questions will not be dealt with in any detail in this paper it would be worth future consideration in any discussion relating to the review of monitoring programs. Real-time monitoring certainly has a place in assessing workplace exposures, as discussed by Pearce & Coffey (2011), and in the control of exposures, as discussed by Worland & Collins (2019).

Critical Control(s) Focus is Best

Regular monitoring of potentially hazardous health exposures does not necessarily mean personal monitoring of workers in a SEG. It can include checking or verifying to ensure that controls are working as intended. In particular, checking that the controls are performing to defined performance criteria so as to prevent undesirable exposures from occurring. Some controls are more important than others. These critical controls and their ongoing adequacy should be monitored more regularly. One of the authors (Di Corleto, 2015) has previously expounded on the evolution of a critical health risk management approach involving the use of the bowtie method.

The International Council on Mining and Metals (ICMM, 2015a) has published a good practice guide to health and safety critical control management (CCM), which outlines the approach to CCM for use in the mining and metals industry. It aligns risk management and good management practice. An additional document (ICMM, 2015b) provides guidance to implement the CCM approach. It also provides history and context of the approach, potential benefits and obstacles, and how an organisation can adopt CCM.

CCM is an integral part of risk management and aids in identifying the priority risks in a company, through the use of hazard and control assessment, and implementing critical controls to prevent an incident or mitigate its impact. The CCM process was primarily intended as a practical method of improving managerial control over rare but potentially catastrophic events by focusing on the critical controls. The approach can be adapted to general exposure scenarios to carcinogenic or other agents at harmful levels and directs the focus to key high-level controls rather than promoting lower level controls i.e. PPE. It can also reduce the emphasis on large gravimetric monitoring programs directing resources to maintaining effective control approaches.

The CCM approach focuses on:

- identifying what controls are needed (many controls will already be in place);
- identifying the critical controls; and
- ensuring supervisors and managers are monitoring the critical controls to check they are providing in practice what they are assumed to provide.

Under these conditions of monitoring, workplace exposure monitoring will only be required when there remains uncertainty as to whether the WES has been exceeded or not.

Conclusions

As noted in Grantham and Firth (2014), in situations where unacceptable exposures are likely, as determined by monitoring or risk assessments, the obligation must always be to control the exposure and then verify that controls are effective through subsequent exposure assessment monitoring. It must be remembered that monitoring of workplace exposures is never the primary goal but monitoring if utilised judiciously can be a powerful tool to assist in establishing the adequacy of controls for hazardous exposures without stretching available resources.

A guiding principle in undertaking compliance monitoring is to minimise unnecessary and costly monitoring and still provide reliable decision making. In plain terms, the legislation seeks the following:

- Air monitoring of an airborne hazardous substance may be required if you cannot assess the risk by simpler means.
- In the case of significant risk, controls should be introduced first and followed up by monitoring. Controlling exposure is still the most important task.

Professional judgement can be applied to many circumstances where adequacy of control can be correctly gauged without the need for monitoring (Grantham & Firth, 2014). Exposure monitoring is a resource intensive exercise, so making measurements in the workplace is always going to be restricted. It is often not practical to make a large number of measurements just to be completely sure of what the real situation is.

Those making measurements need to know how to approach their monitoring strategy from a practical perspective and often will have to make do with fewer data. The strategy provided in EN 689 (2019) combined with the critical control management (CCM) approach are useful tools to meet this objective.

Small to medium businesses often struggle to take on the additional resource burden of an extensive monitoring program and large organisations often look to improve efficiencies. Assessment and management programs need to be designed to be as simple as is practical and focus on the key effective controls to ensure their integrity. This will provide confidence and security for the Regulator, the business and most importantly the worker.

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