Workplace Chemical Exposure Monitoring

Introduction

OSHA has established exposure limits to protect employees from overexposure to hundreds of hazardous airborne contaminants. The primary OSHA exposure limits are known as the Permissible Exposure Limits (PELs) which are usually 8 hour time weighted average (TWA) values that are not to be exceeded for the work day. In addition, for some substances, OSHA has also established Short Term Exposure Limits (STELs) and Ceiling Limits (CL) that should not be exceeded at any time during a workday. Exposure limits are published in *29 CFR 1910.1000 Air Contaminants* and in other OSHA chemical specific standards

OSHA regulations require that employees are not to be exposed to hazardous airborne contaminants above the established exposure limits. If a condition exists that is in excess of an exposure limit, engineering controls, administrative controls, and personal protective equipment (PPE) must be evaluated to determine appropriate actions to reduce the exposure to below the allowable exposure limit. Some other OSHA standards have specific requirements regarding engineering controls, administrative controls, and the use of PPE. Employee exposure monitoring and subsequent analysis is the only accurate means to determine compliance with these standards. Certain chemical-specific OSHA standards, such as the recent methylene chloride rule specifically require such monitoring.

Monitoring and Measurement Requirements

While there are a variety of methods available to conduct workplace exposure monitoring, not all of these are recognized by OSHA as suitable for compliance monitoring. Where monitoring is required, OSHA has established their minimum requirements as follows:

Short Term Exposure Evaluation

Where there are recognized effects from short term exposures to a substance whose toxic effects are primarily of a long term exposure nature, short term exposure limits (STELs) are often established.

A short term exposure limit (STEL) is usually defined as a 15 minute TWA exposure which should not be exceeded at anytime during the workday. When a compound has an assigned STEL, short term monitoring should be done for activities/areas that have the greatest potential for exposure. STEL monitoring is supplemental to eight hour TWA monitoring. Air samples must be taken in the employee's breathing zone.

Eight-hour exposure evaluation

Eight hour exposure evaluation (an 8 hr TWA) is done for the purpose of determining average employee exposure during a full shift. This is best done by taking consecutive full shift samples over a period of several days. Air samples must be taken in the employee's breathing zone.

Monitoring techniques

Air monitoring may be performed by collecting the solvent vapor onto adsorption tubes with subsequent analysis by an AIHA accredited laboratory. Sampling and analysis may also be performed by instruments such as real-time continuous monitoring systems, portable direct reading instruments, or passive dosimeters as long as measurements taken using these methods accurately evaluate the concentration of the solvent in employees breathing zones. The breathing zone can generally be described as being a location, exposed to ambient air, within 12 inches of the mouth. Since many of the duties relating to employee exposure are dependent on the results of measurement procedures, employers must assure that the evaluation of employee exposure is performed by a technically qualified person.

The employer has the obligation of selecting a monitoring method which meets the accuracy and precision requirements of the standard under any field conditions that may be present.

Monitoring and Measurement Procedures

Monitoring: The monitoring process includes both a sampling step and an analytical step. A monitoring program may include both short and long term monitoring. Long term monitoring is typically considered full shift monitoring (typically 8 hours), while short term monitoring is usually based on a sample collected over a 15 minute timeframe. Professional assistance, preferably a Certified Industrial Hygienist (CIH) may be required to design a suitable monitoring program, to interpret the results of sampling and to make appropriate recommendations. There are a variety of options available to conduct these types of monitoring, each with its own advantages and disadvantages.

Sampling: The sampling step involves the collection of an air sample from the employee's breathing zone. There are many different types of devices available to sample hazardous substances in ambient air, including: tubes (direct reading or chemical sorbent), mechanical instruments, and passive badges. Selection of the sampling method will depend on the nature of the monitoring requirement

Measurement: The measurement, or the analytical step is where the sample is analyzed to determine the amount of air contaminant present. Direct reading devices perform the analysis internally, but may require a simple calculation. Samples collected on chemical sorbent tubes will require a separate analytical step, preferably done by an AIHA accredited laboratory.

Short Term Monitoring

Since specific standards may list different times frames in which to collect a STEL, it will be necessary to first review the applicable standard. Short term monitoring is intended to be representative of peak/brief exposure events and is not usually representative of TWA exposures.

Short term monitoring is usually conducted to determine the presence and amount of air contaminants in a 15 minute period of time for activities that are considered to have the greatest potential for exposure. Short term monitoring may be used to indicate the need for further testing. Short term monitoring should not be used in place of continuous air monitoring nor be used to demonstrate compliance with OSHA PELs. A single brief sample that is applicable to ceiling limits or STELs may not be applicable to the 8 hour TWA**.**

Short Term Monitoring Equipment

Detector tubes or colorimetric indicator tubes are often used for rapid detection and measurement of contaminants in the air. A detector tube is a sealed glass tube containing materials designed specifically for identifying and quantifying groups of chemicals. A color change is often used to indicate the presence of air contaminants and the approximate concentration present. Some detector tubes are more specific and selective than others. The manufacturer's instructions provide the user information on how to collect a sample and interpret the tube. Qualitative indicator tubes are used as yes-no tubes to alert the user of the presence of air contamination. Because they contain reactive chemicals, these tubes are sensitive to conditions that affect a chemical reaction such as temperature, humidity, the presence of other vapors and gases, and the location of sampling

Direct Reading Tubes and Badges

Some advantages of this type of monitoring are:

- lower capital investment,
- simple operation,
- immediate results

Some disadvantages are:

- cross sensitivity
- limited to monitoring only one substance at a time
- cannot always be used for TWA exposure evaluation
- there's not a device for every compound.
- Limited Shelf Life

Long Term Monitoring

Long term monitoring is used to monitor full shift exposures (typically 8 hours) and may employ either active or passive sampling systems. Equipment that can be used for long term sampling includes mechanical sampling systems (battery operated pumps), long term direct reading detector tubes (passive and active), passive dosimeters/badges (direct reading or analysis required). This equipment can be used for both personal and area monitoring.

Active sampling systems

Active sampling systems require the use of an appropriate sorbent tube connected to a small mechanical pump (diaphragm or peristaltic), which pulls air through the tube at a specified rate. Active sampling systems include adsorbent media tubes and specific detector tubes.

Advantages of an active system include:

- multiple compounds can often be collected at the same time,
- lower limits of detection,
- can be used to determine 8 hr TWA compliance when a NIOSH/OSHA validated method is used for collection and analysis.

Disadvantages of this type of system include:

- cost of equipment
- technical expertise needed to calibrate and operate
- tubes must be sent to an American Industrial Hygiene Association (AIHA) accredited lab for analysis - so results can take a week to get.

Long term detector tubes are designed similarly to short term detector tubes. These tubes can be either passive or active. Active type tubes require the use of a mechanical air pump to pull air through the tube. The tubes are usually clipped onto clothing in the breathing

zone of an employee or a place in the work area that you want to know what the levels might be. The manufacture's instruction sheet will provide guidance on use and interpretation.

Passive Sampling Systems

Passive sampling devices depend on air currents and diffusion to move contaminants into the tube or badge instead of relying on a pump. A passive sampling device is easy to use and relatively inexpensive. Some passive sampling devices are colormetric and are designed to be compared to a color chart. Others have a scale attached to it and are direct reading.

These passive direct reading tubes/badges are easy to use but may sometimes be difficult to interpret due to uneven coloring. Temperature and humidity conditions and the presence of other gases or vapors effect passive sampling devices. Therefore, results should be considered as a range rather than a single number. Some passive sample devices may require analysis by a laboratory.

Sometimes the cost of the device may include analysis cost. Be sure to ask before purchasing. If analysis is needed and not available from the manufacturer, the use of an AIHA accredited laboratory is recommended.

Advantages of a passive badge system are:

- ease of use
- capable of sampling multiple compounds,
- no technical equipment needed (pumps or calibrators),
- analysis cost often part of purchase cost.

Disadvantages include:

- shelf life of materials often shorter,
- contamination through handling,
- results take as long to get as does the active system.

Advantages and disadvantages of passive tube systems are similar to detector tubes. Low cost, most are direct reading, but they may have cross sensitivities and higher limits of detection. When used according to manufacturer instructions, these type of samples can be used for 8 hr TWA compliance monitoring.

Event Data And Reporting

A successful monitoring process will involve collection of samples that are representative of the actual exposure conditions at the monitoring area. How well a sample represents the conditions of a monitoring area depends on several factors. The most important factors are the employees' activity and plant operating conditions. Therefore, a chronological log of work related events for each monitored employee is helpful when evaluating the results. Once the samples are analyzed, it is important for the employer to be aware that the results are subject to the provisions of 29 CFR 1910.20 *Access to Employee Exposure and Medical Records* which requires employers to allow their employees access to exposure records.

References

Methylene Chloride, US Department of Labor, Occupational Safety and Health Administration, OSHA 3144, 1997

29 CFR Part 1910.1000, *Air Contaminants*

Occupational Exposure to Methylene Chloride, Final Rule, *Federal Register* January 10, 1997
(62 FR 1493)

Equipment And Service Suppliers

The following is a listing of some companies that can be contacted for monitoring equipment and evaluation. The suppliers listed here are believed to be reliable. Listing in this section is for information only and should not be considered as an endorsement or as a recommendation for one supplier's product over another.

Primary Service Providers (including analysis)

Assay Technology
1070 E Meadow Circle
Palo Alto CA 94303
800-833-1258 http://www.assaytec.com

Enviroguard
113 Phillips Medical Way
Apex, NC 27502
800-499-7232

Gilian Instrument Corp.
350 Fairfield Place
West Caldwell, NJ 07006
201-808-3355

International Fabricare Institute.
12251 Tech Road
Silver Spring, MD 20904
800-638-2627 http://www.ifi.org

3M
Occupational Health and
Environmental Safety Division..
3M Center, Building 275-6W-01
St. Paul, MN 55133-3275
800-243-4630 http://www.mmm.com/occsafety

SKC Inc.
863 Valley View Road
Eighty Four, PA 15330
800-752-8472 http://www.skcinc.com

Equipment Manufacturers

National Draeger, Inc.
101 Technology Drive
Pittsburgh, PA 15230
800-922-5518

Sensidyne, Inc
16333 Bay Vista Drive
Clearwater, FL 34620
800-451-9444

Equipment Distributors

Note: Even if not listed here, the company you use for obtaining safety equipment may also be able to assist you in obtaining sampling equipment.

Lab Safety Supply.
401 S Wright Rd
Janesville, WI 53547
800-356-0783 http://www.labsafety.com
800-356-2855 (TR)

Labelmaster.
5724 N Pulaski Rd
Chicago, IL 60646-6797
800-621-5808 http://www.labelmaster.com

Vallen Safety Supply Company:
13333 Northwest Freeway
Houston, TX 77040
800-482-5536 http://www.vallen.com