

Technical Basis for Assessing Low Risk Exposures

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Table of Contents

SUMMARY 3

DISCUSSION 4

 AN AGENT DOES NOT MEET THE OSHA DEFINITION OF HAZARDOUS 9

 AGENTS WHERE EXPOSURES ARE CONTROLLED BASED ON RECOGNIZED
 ENGINEERING CONTROLS 10

 AGENTS WHERE EXPOSURES ARE CONTROLLED BASED ON OSHA'S
 CONSUMER PRODUCT EXEMPTION AND ARTICLES 12

 AGENTS AT CONCENTRATIONS THAT DO NOT REQUIRE CONTROLS PER
 OSHA OR DOE 14

 AGENTS USED IN A MANNER THAT ARE NOT CAPABLE OF EXCEEDING OELS
 WHEN MODELED, AND AGENTS WITH PROPERTIES THAT MAKE THEM
 DETECTABLE AT CONCENTRATIONS BELOW OELS 14

CONCLUSION 16

DEFINITIONS 17

REFERENCES 18

List of Tables

Table 1 Criteria for Evaluation of Risk Where No Exposure Limit
Has Been Established 5

Table 2 Examples of OSHA Identified Hazardous Materials 10

SUMMARY

Note to readers - It is presumed that readers have an understanding of how the Department of Energy and the American Industrial Hygiene Association recommend exposure assessments be conducted. This document is not intended to explain in detail how the industrial hygiene community performs exposure assessments.

10 CFR Part 851, *Worker Safety and Health Program*, affirms the Department of Energy's expectation that chemical, biological, and physical agents in the workplace will be controlled to prevent workers from experiencing adverse health effects. A systematic and comprehensive approach that allows an accurate assessment of risks is the most efficient way to accomplish this goal. The Department of Energy and the American Industrial Hygiene Association both recommend that agents in the workplace be evaluated using an approach referred to as exposure assessment. Properly conducted, exposure assessments are a valuable tool for identifying the nature and magnitude of health risks from agents in the workplace. When deciding on how resources will be dedicated to exposure assessments, it is logical that they be allocated in a manner that balances the desire to fully characterize all possible exposures with the reality that resources are limited and need to be focused where the risk to workers is greatest. For agents in the workplace where risks are clearly controlled, there is little benefit in performing exhaustive assessments and workplace monitoring. Instead, when risks have been determined to be low in a technically supported fashion, only periodic, limited scope re-evaluations become necessary to ensure worker protection. Addressing agents in this manner is in effect implementing a graded approach to risk management. The benefit of this type of approach is that it allocates resources in a manner that have the greatest probability of protecting workers from those agents that have a substantive adverse affect potential risk for workers.

DISCUSSION

Controlling workplace hazards, which protects workers, is a cornerstone of industrial hygiene.⁽¹⁾ From the industrial hygienist's perspective, a workplace hazard is a chemical (includes radiological chemicals), biological, or physical agent that has the capability of producing adverse effects on the health and safety of workers. Stated simply, exposure to chemical, biological, or physical agents in excess of established limits can pose a hazard, and the greater the exposure, the greater the need for compensatory action.

To control exposures, it is necessary that employers identify and evaluate the hazardous agents that workers encounter in the workplace. This process is referred to as conducting exposure assessments. Performing and periodically updating exposure assessments are critical steps in protecting workers.⁽²⁾ While exposure assessments begin the process of protecting workers, properly done, they also provide additional benefits that include:

- minimizing the stress to workers from over-use of protective equipment,
- providing information useful for epidemiological studies,
- managing future risk,
- demonstrating compliance with regulations,
- directing resources in an efficient manner.

Conducting exposure assessments has evolved to a point where it is recognized as a process unto itself. The American Industrial Hygiene Association (AIHA) has formalized an approach to exposure assessments in the publication, *A Strategy for Assessing and Managing Occupational Exposures*.⁽²⁾ Briefly, the steps include the following:

- Establish a formal exposure assessment strategy,
- Obtain the information needed to perform an exposure assessment,
- Establish Similar Exposure Groups (SEG),
- Collect information about the exposures within the SEGs - prioritizing exposures judged to pose the greatest hazard,
- Implement controls based on the hazard posed by exposures.
- Once controls are implemented, the exposures must be reassessed and controls adjusted as appropriate.
- Reassess exposures within SEGs on a frequency based on the hazard, and
- Exposure assessment determinations, impact of controls, the effect of the controls on exposures, and results of reassessments must be documented for future use.

It is accepted that exposure assessments must be conducted on those agents which have the potential to harm workers. While occupational safety and health professionals agree that exposure assessments must be conducted, it is not intended that the same level of effort be applied to all agents. To plan on extensively evaluating **all** agents equally is unrealistic. Instead, an efficient and effective occupational safety and health program must concentrate on exposures that can affect worker health rather than on

those that can be shown to have no reasonable chance of affecting worker health. By minimizing resources expended on exposures that have no reasonable chance of affecting workers, employers and employees benefit because recognized hazards can be better controlled and there is a greater chance of identifying previously unrecognized hazards. In essence, when deciding how best to protect workers, the resources available must be directed against the real, versus perceived or low risk, hazards.

When discussing hazards in workplaces, the terms exposure and toxicity (or toxic agent) are often interchanged. While measuring exposures and determining toxicity (or damage from a physical agent) can be objective, determining if an agent presents a hazard is frequently more subjective. Often, all exposures to chemical, biological, or physical agents are assumed to present a hazard to workers that must be controlled. This incorrect assumption ignores the fact that toxic agents can be present in the workplace and workers not be exposed to them. Likewise, hazard from an agent can be very low if the agent is in a very dilute form regardless of the toxicity of the agent. In determining that a particular agent presents a hazard, there must be a realistic chance for a worker to receive a sufficient dose of the agent. If a worker does not inhale, ingest, absorb, inject, or contact a sufficient quantity of the agent, then the agent does not pose a credible hazard to a worker, regardless of how toxic or damaging the agent.⁽³⁾

When evaluating agents in the workplace, comparisons to established exposure limits are often used to gauge the degree of hazard present. While exposure limits are extremely useful in assessing workplaces, recognized limits are available for less than one percent of chemicals used in industry.⁽²⁾ As such, it is often necessary to use alternative information to determine if an exposure represents a hazard. To this end, industrial hygienists have categorized chemicals based on their relative acute toxicity.⁽³⁾ The following table lists criteria that can be used to assess agents for which no exposure limit has been established.

Degree of acute toxicity	LD 50 Single Oral Dose – Rats (g/kg)	4-hr Vapor Exposure Causes 2-4 Deaths in 6-Rat Group (ppm)	LD 50 Skin for Rabbits (g/kg)	Probable Lethal Dose for Humans
Extremely toxic	≤0.001	<10	≤0.005	Taste (1 grain)
Highly toxic	0.001-0.05	10-100	0.005-0.043	1 tsp (4 cc)
Moderately toxic	0.05-0.5	100-1,000	0.044-0.340	1 oz (30 gm)
Slightly toxic	0.5-5.0	1,000-10,000	0.35-2.81	1 pint (250 gm)
Practically nontoxic	5.0-15.0	10,000-100,000	2.82-22.6	1 quart
Relatively harmless	>15.0	>100,000	>22.6	>1 quart

Table 1 Criteria for Evaluation of Risk Where No Exposure Limit Has Been Established

Such ratings are particularly valuable when determining the effect an exposure may have on workers. For example, if a worker was to receive an intake of one ounce of a chemical with a rating of 'practically nontoxic', no health effect would be expected. While agents that fall in the 'practically nontoxic' to 'relatively harmless' categories have a measurable toxicity, expending limited resources on in-depth exposure assessments and monitoring is not prudent or cost effective and should not receive high priority.

When discussing ionizing radiation, exposures are typically controlled to "As Low As Reasonably Achievable" or ALARA. This is based on the philosophy that any increase in radiological exposure results in a commensurate increase in health risk for the exposed individual. Essentially, radiological protection practices do not accept the concept of a threshold below which no adverse effects are expected.

While effective industrial hygiene programs will never permit exposures that can adversely affect workers, in nonradiological operations, the concept of ALARA is not applied. Instead, exposures are controlled to levels "As Low As Practicable" or ALAP. Applying ALAP to nonradiological hazards is acceptable because it is understood that for most nonradiological agents, there is a threshold below which no adverse effects are expected. Thresholds, while potentially controversial, are an important reality and are included in the protocols used to establish and apply exposure limits.⁽⁴⁾

Recognizing the existence of thresholds, one can conclude that a nonradiological agent is not a hazard if sampling, modeling, or objective estimates demonstrate that exposures are well below the respective limit. In fact, provided that representative exposures are less than 10 – 25 percent of an exposure limit, it can generally be assumed that the exposures in that situation would clearly be acceptable.⁽²⁾

It follows that when exposures are clearly below the point where they represent a hazard, it is logical that a graded approach is appropriate; the degree of exposure assessment and monitoring applied should follow the degree of risk.

Accepting the practicality of using a graded approach when conducting exposure assessments and monitoring is supported by the fact that to do otherwise often fails to provide a commensurate benefit to the workforce as a whole. The following paragraph from the *AIHA White paper on Risk Assessment and Risk Management* provides insight into this situation.⁽⁵⁾

"The Environmental Protection Agency (EPA) regularly estimates the annual cost of compliance with its regulations in the billions. Recent analyses of resource allocations in the EPA ("Unfinished Business") have indicated a mismatch between these allocations and the sources of environmental and human health risk. For example, tremendous sums of money have been directed at hazardous waste site remediation, a relatively low source of risk, while minimal resources have been applied to reducing the very real risk of radon exposure. The studies blamed a

variety of factors, including mandated programs, public concerns about low-risk environmental issues, and reduction of risk in some areas due to program efforts. Increasing awareness of potential misallocation of scarce resources, along with concern about high levels of uncertainty and conservative default values (i.e., assumptions used in the absence of scientific data) used in risk assessment, and instances of public frustration with risk communication efforts, have led to the passage of legislation in the United States Congress and to Executive Branch actions. The 1996 Safe Drinking Water Amendments included provisions for the integration of scientific and economic analysis as the basis for determining standards under the Act. Such integration was called for in the Office of Management and Budget implementation guidelines under Executive Order 12866.”

While not minimizing the value of increased regulation and risk reduction, it is apparent that performing in-depth exposure assessments on all agents, or otherwise not applying a graded approach, is not a practicable goal.

Occupational safety and health professionals understand and accept the responsibility to “Provide a place of employment free from recognized hazards that are causing or have the potential to cause death or serious physical harm to workers” as required in Subpart B, Program Requirements, from 10 CFR 851.10(a)(1). While ‘free from recognized hazards’ is identified as a requirement, defining what constitutes success in achieving this is subject to interpretation. To determine the intent of ‘free from recognized hazards’, one can look to the Preamble to 10 CFR Part 851 (Preamble).

A review of the Preamble, as well as documents referenced in the 10 CFR Part 851 provide insight into the intent of the requirement identified in section 851.10(a)(1). The Preamble and the references discussed in the 10 CFR Part 851 indicate that it is not DOE’s expectation that **all** exposures be assessed and receive quantitative monitoring. Rather, the Preamble expects that resources “...be effectively allocated to address safety, programmatic, and operational considerations” and before work is performed, “...an agreed-upon set of safety standards and requirements must be established which, if properly implemented, will provide adequate assurance that...workers...are protected from adverse consequences.”⁽⁶⁾

Furthermore, the draft implementation guide for use with 10 CFR Part 851, DOE G XXX, DRAFT 5-02/27/06 identifies additional references for contractors.⁽⁷⁾ Section 3.3.2.1.1, “Assess workers exposures”, indicates that guidance on workplace monitoring is provided in DOE G 440.1-3, Occupational Exposure Assessment.⁽⁸⁾ In the Definitions section of DOE G 440.1-3, Section 3.2, DOE supports the concept of an Administrative Control Level (ACL), stating an ACL is “The airborne concentration of a chemical contaminant below which additional assessment may not be necessary. The ACL should be initially set at 10 percent to 25 percent of an occupational exposure limit (OEL) and should be confirmed or changed as monitoring data and hazard analyses become available. DOE G 440.1-3 explains that “...based on statistics, the probability

of exceeding the OEL is less than 5% if initial, random “measured” exposures are less than one-tenth the OEL and if exposures are not too highly variable.” It follows that for chemicals used in very small quantities or in well controlled situations (i.e., laboratory hoods) where exposures are well below the OEL, there will be no need to perform in-depth exposure assessments or workplace monitoring. Furthermore, DOE G 440.1-3 defines a health hazard with clear reference to OSHA’s Hazard Communication Standard in that “...Appendix A of 29 CFR 1910.1200 provides further definitions and explanations of the scope of health hazards....” DOE G 440.1-3 also recognizes the AIHA Exposure Assessment Strategy which accepts a graded approach in exposure assessments and monitoring.

Those hazards where it is evident that risk to workers is present, as well as those for which the risk is not clear, AIHA and DOE accepted exposure assessment and monitoring strategies are clearly required. However, for those agents that reasonably will not pose a hazard to workers, it would be valuable to address them in a categorical fashion. Agents that fall into such categories would receive only a limited exposure assessment and typically not be subject to workplace (air, biological, or surface) monitoring. Such an approach can go far in balancing risks and resources. While this approach is not necessarily novel and was often done in the past, the bases for the decisions were often not documented or, at best, poorly documented. The lack of such documentation is often interpreted as an indication that exposure assessments were not conducted - which is often not the case.

A goal of this document is to provide a technical basis for identifying predictable exposures which warrant minimal exposure assessments and little to no workplace sampling. Such a process will allow occupational safety and health professionals to demonstrate compliance with the intent of 10 CFR Part 851 and effectively allocate resources. Examples of such criteria would include the following:

- Agents, and in particular chemicals, that do not meet OSHA’s definition of hazardous as outlined in the Hazard Communication Standard
- Agents used with engineering and administrative controls, often actually described in OSHA regulations, that are reasonably expected to control exposures below OELs
- Agents used in a manner that comply with OSHA’s Consumer Product Exception
- Contain carcinogenic and other agents at concentrations that does not require controls per OSHA, DOE, or ACGIH
- Agents used in a manner that are not capable of exceeding OELs when modeled
- Agents with properties that make them detectable at concentrations below OELs

Once an exposure scenario is shown to meet any of these criteria, provided professional judgment does not dictate otherwise, the documentation which describes the exposure scenario would be considered to be a satisfactory exposure assessment. Each of the scenarios is discussed individually below.

AN AGENT DOES NOT MEET THE OSHA DEFINITION OF HAZARDOUS

OSHA defines an agent as being hazardous, if it meets one or more of the following criteria:

- Is carcinogenic
 - Found to be a carcinogen or potential carcinogen by the International Agency for Research on Cancer (IARC)
 - Listed as a carcinogen or potential carcinogen in the latest edition of the Annual Report on Carcinogens published by the National Toxicology Program (NTP)
 - Is regulated as a carcinogen by OSHA
- Is corrosive
 - Destroys or changes irreversibly the structure of tissue of intact skin (tested per 49CFR173 using albino rabbits) following a four hour exposure
- Is an irritant
 - Causes a reversible inflammatory effect on living tissue by chemical action (tested per 16CFR1500.41 at the site of contact using albino rabbits) following a four hour exposure or is an eye irritant when tested per 16CFR1500.42
- Is a sensitizer
 - Causes a substantial proportion of exposed people or animals to develop an allergic reaction in normal tissue after repeated exposure to the chemical
- Is toxic
 - Oral - Has a median lethal dose (LD50) of less than or equal to 500 milligrams per kilogram when administered orally to albino rats weighing between 200 and 300 grams each
 - Skin Contact - Has a median LD50 of less than or equal to 1,000 milligrams per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) to the bare skin of albino rabbits weighing between two and three kilograms each
 - Inhalation – Has a median LC50 of less than or equal to 2,000 parts per million by volume for gases or vapors, or less than or equal to 20 milligrams per liter for mists, fumes, or dusts, when administered by continuous inhalation for one hour (or less if death occurs within one hour) to albino rats weighing between 200 and 300 grams each

- Has a target organ effect (Chemicals which have been found to cause organ-specific effects). The examples following each class are not all-inclusive.

Effects	Chemical	Signs & Symptoms
Hepatotoxin	Carbon tetrachloride, nitroamines	Jaundice, liver enlargement
Nephrotoxin	Halogenated hydrocarbons, uranium	Edema, proteinuria
Neurotoxin	Mercury, carbon disulfide	Narcosis, behavioral changes, decreased motor function
Act on blood or hemato-poietic systems	Carbon monoxide, cyanides	Cyanosis, loss of consciousness
Lung damage	Silica, asbestos	Cough, tightness in the chest, shortness of breath
Reproductive toxin	Lead, DBCP	Birth defects, sterility
Cutaneous hazards	Ketones, chlorinated compounds	Defatting of the skin, rashes, irritation
Eye hazards	Organic solvents, acids	Conjunctivitis, corneal damage

Table 2 Examples of OSHA Identified Hazardous Materials

Assuming an agent does not meet OSHA's definition of being hazardous, and no other considerations are relevant, a minimal exposure assessment would be acceptable and the agent would not merit workplace monitoring.

AGENTS WHERE EXPOSURES ARE CONTROLLED BASED ON RECOGNIZED ENGINEERING CONTROLS

In many workplaces, exposures are controlled using engineered devices – the preferred approach when the exposure can not fully be removed from the workplace. The devices can be permanent (such as laboratory hoods or radio-benches, exhaust trunks associated with welding stations, and individually exhausted stationary tools). The devices can also be portable (such as drum hoods with localized exhaust). Provided that the devices meet designs accepted by OSHA or other recognized design agencies, it is logical to conclude that, for the agents considered as part of the design, exposures will be below established limits. Credit for such exposure controls requires three necessary elements: adequate design, mechanisms for validation of use as to operation (testing or surveillances) and behaviors of personnel working with them (self assessments).

Examples of effective engineering controls are provided in the American Conference of Governmental Industrial Hygienists (ACGIH) Industrial Ventilation A Manual of Recommended Practice (Ventilation Manual)⁽⁹⁾. The Ventilation Manual has traditionally been recognized by industrial hygienists, engineers, and governmental agencies as a source for designing local exhaust systems as well as a guide for dilution air, general mechanical exhaust, worker comfort, and fire and explosion control. The Ventilation Manual provides examples of equipment for specific processes such as dip tanks, welding tables, grinders, drum loading/unloading as well as laboratory hoods and gloveboxes. In addition, the Ventilation Manual includes a step-by-step philosophy for designing more elaborate systems that are unique to a particular operation not otherwise addressed. That philosophy includes, among other considerations, the toxicity of the contaminants, generation rate, workplace layout and conditions, need for worker access, and environmental release consequences. These systems will capture contaminants at the source and remove them from the workplace.

Regulations have also been established for some operations by OSHA which is expected to maintain specific agents below established exposure limits. For example, OSHA's 29CFR1910.252 Subpart Q, Subpart Title "Welding, Cutting, and Brazing", establishes ventilation requirements for general welding and cutting. Section 1910.252(c)(2)(i) states that for metals not specifically addressed in paragraphs 1910.252(c)(5) - (c)(12), natural ventilation is considered sufficient for welding or cutting operations provided the following are present:

- There is at least 10,000 cubic feet of work area per welder
- The ceiling height is at least 16 feet
- No confined space is involved and no partitions, balconies, or other structural barriers significantly obstruct cross ventilation

The adequacy of natural ventilation for many welding processes is also supported by independent sources such as the Ohio State University in its training program titled "Arc Welding Safety" available at the website.⁽¹⁰⁾

In the event that any of the three situations noted above are not present, then general mechanical ventilation at a rate of 2,000 cubic feet per minute per welder will be required unless local exhaust or respiratory protection are used. The adequacy of natural ventilation for general welding or cutting is also supported by NIOSH publication *Safety and Health in Arc Welding and Gas Welding and Cutting*, DHEW (NIOSH) Publication No. 78-138, January 1978.⁽¹¹⁾

When natural or mechanical ventilation is not employed and local exhaust (hoods or booths) is provided, Paragraph 1910.252(c)(3) describes control velocities and exhaust flows with associated duct diameters that, when properly positioned, are capable of providing an exhaust velocity of 100 linear feet per minute (fpm) in the zone of welding. Provided the equipment is properly used and is operating as designed, the exhaust system will be adequate to control welding contaminants not specifically addressed (in 1910.252(c)(5) – (c)(12)) to below established limits. *Engineering Control of Welding Fumes*, DHEW Publication No. (NIOSH) 75-115, supports 100 fpm as acceptable in

controlling exposures by confirming that "...the recommendations represent minimum system operating states which resulted in a breathing zone additive effect that was equal to or less than the mixture TLV[®] or Exposure Threshold at **100 percent arc time**" [emphasis added].⁽¹²⁾ Since rarely would actual weld time approach 100 percent, it is unlikely that exposures would exceed established limits. In addition, the article, "Reducing Exposure to Hexavalent Chromium in Welding Fumes," *Welding Journal*, August 2006, supports the NIOSH document in stating, "The rule of thumb is in order for LEV to be effective, it must achieve a minimum air velocity of about 100 ft/min at the point of fume capture."⁽¹³⁾

For agents specifically identified in 1910.252(c)(5) – (c)(12), employing the controls specified are expected to control exposures to below established limits.

Caution is warranted when taking credit for this approach if contaminants present or generated are not actually removed from worker's breathing zone. As an example of when caution is necessary, while an appropriately tested HEPA filter can be expected to remove particulates, it will not remove gases or vapors; sorbent filters or ductwork exhausting beyond the work area may be needed. Likewise, should the device not be used properly or not operate per design, taking credit for the device may not be appropriate. As a result, when taking credit for engineered controls, a program for testing the operability of the equipment and filters (if present) is required.

In summary, when an engineered control meets accepted design, is routinely used, and is shown to be operating to design, it is reasonable to conclude that a minimal exposure assessment would be acceptable and the agent would not merit monitoring beyond that required by substance-specified OSHA or DOE requirements.

AGENTS WHERE EXPOSURES ARE CONTROLLED BASED ON OSHA'S CONSUMER PRODUCT EXEMPTION AND ARTICLES

In the Scope and Application section of 29 CFR 1910.1200, *Hazard Communication Standard* (HCS), OSHA identifies those applications to which the Hazard Communication Program does not apply. Included among the exceptions are, "Any consumer product or hazardous substance...where the employer can show that it is used in the workplace for the purpose intended by the chemical manufacturer or importer of the product, and the use results in a duration and frequency of exposure which is not greater than the range of exposures that could reasonably be experienced by consumers when used for the purpose intended."⁽¹⁴⁾ OSHA has also provided interpretations to expand on the intent of the consumer product exemption. In a letter of interpretation, "Requirements for maintaining material safety data sheets (MSDSs) for consumer art products and office cleaning products," Jonathan L. Snare to Beverly Cohen, April 14, 2005, OSHA provides a general statement that, "The consumer product exemption of the HCS applies to the use of those products only if the employer

can demonstrate they are used in the same manner (e.g., with the same frequency and duration of use) as a normal consumer would utilize them.”⁽¹⁵⁾ Within the same letter, OSHA gives examples of specific products which can be excluded from the Hazard Communication Program when it is stated, “If your client's employees utilize the office cleaning products you mention (Windex and Office Cleaner) with the frequency and duration as that of a normal consumer, then the use of those cleaning chemicals would fall under the HCS exemption for consumer products, 29 CFR 1910.1200(b)(6)(ix)”.

OSHA has provided additional clarification in a letter of interpretation, “Hazard Communication: classification of uninterruptible power source batteries and office chemicals as consumer products,” Richard E. Fairfax to Elaine B. Enfonde, July 8, 2004.⁽¹⁶⁾ In this letter of interpretation, OSHA states that it “...considers office chemicals such as white out, cleaning chemicals, and copier chemicals to be exempt under the provisions of the rule, as consumer products.” OSHA also provides guidance on items that are not typical of office environments. For the case of small uninterruptible power supply batteries that supply backup power to individual computers, the batteries are considered to be consumer products and not covered by the Hazard Communication Standard. In a scenario involving banks of batteries that supply larger equipment, the personnel who service the equipment would be covered by the HCS. However, co-located workers not involved in maintaining the batteries would not be covered by the

HCS despite the fact that the batteries “...have the potential to leak, spill, or break...and expose employees to sulfuric acid and lead...and hydrogen gas....”

As such, it is reasonable to conclude that agents used in a manner that meets OSHA's Consumer Product Exception would not merit in-depth exposure assessments or workplace monitoring. Obviously, if the use was in a manner not intended by the manufacturer, or the amount used was excessive, a more extensive exposure assessment, and possibly monitoring, would be considered.

Of particular note, agents which meet OSHA's classification as 'articles', which by definition cannot produce a hazard to workers, fall into a category which require no exposure assessment or monitoring, and more importantly would not require inclusion into a Similar Exposure Group. Articles can typically be addressed categorically regardless of their workplace location. Examples include the following:

- pH and other indicating papers,
- plotter and paint pens
- instrument batteries (i.e., AA-cell, D-cell, 9-volt, etc.),
- classes I and II lasers as well higher class lasers (except for alignment, service, and maintenance of those lasers) which are embedded and classified as a Class I or II laser system.

AGENTS AT CONCENTRATIONS THAT DO NOT REQUIRE CONTROLS PER OSHA OR DOE

Often, the presence of a toxic chemical or occupational carcinogen in a solution or product creates the perception that an in-depth exposure assessment and subsequent workplace monitoring are required. In reality, because dilute concentrations of agents will generally not present a hazard to workers, OSHA has established concentrations below which a mixture or product is not considered to be a hazard unless otherwise indicated. For noncarcinogenic chemicals, the concentration has been established at one percent or greater. For carcinogenic chemicals, the concentration has been established at a tenth of a percent or greater. Note that when a chemical mixture or product, even when at less than one percent for noncarcinogens or less than a tenth of a percent for carcinogens, can be released at concentrations that would exceed an established exposure limit, then the mixture or product shall be assumed to present the same health hazard as the undiluted mixture or product.

Understanding the emotional nature associated with toxic (and in particular carcinogenic) agents and not conducting an exposure assessment, simply because an agent is present at less than a fixed percentage, must be done with care. However, recognizing OSHA's mission is to protect workers from unacceptable risks, the fact that OSHA has established concentration exclusions indicates that the exclusions can be used in determining the level of effort that should be expended. Clearly, when concentrations of toxic or carcinogenic agents are below one or a tenth of a percent respectively, a limited exposure assessment and little, if any, workplace monitoring is justified.

AGENTS USED IN A MANNER THAT ARE NOT CAPABLE OF EXCEEDING OELs WHEN MODELED, AND AGENTS WITH PROPERTIES THAT MAKE THEM DETECTABLE AT CONCENTRATIONS BELOW OELs

In some instances, agents have properties that render them incapable of exceeding OELs under the conditions of use. In other cases, some agents have properties that make them detectable to most, but not all, workers within a SEG at concentrations below OELs. Examples include the following:

- Physical Properties – Vapor pressure can be used to indicate whether some agents are at concentrations below their exposure limit, and therefore acceptable. If the calculated saturation concentration of an agent, which represents the maximum concentration at a given temperature and pressure, is less than its exposure limit, then the exposure can be judged acceptable. In the event that the calculated saturation concentration of an agent is in excess of its exposure limit,

but adequate dilution air is available to maintain the agent's concentration less than its exposure limit, then again the exposure can be judged to be acceptable. In both of these examples, there would be no need for workplace monitoring since the modeling demonstrates that exposure in excess of established limits is not possible.

- Odor and Recognition Threshold – The American Industrial Hygiene Association (AIHA), in the publication *Odor Thresholds for Chemicals with Established Occupational Health Standards*, provides a range of “experimentally determined odor thresholds” and “best” estimates for the detection or recognition odor thresholds for comparison to the exposure limits.⁽¹⁷⁾ Using the odor and recognition information presented in the AIHA publication, one can judge whether an agent's concentration is below its exposure limit, and therefore acceptable. In situations where the odor or recognition threshold is less than the exposure limit and the agent is not detected in the workplace, there would be no need for workplace monitoring since the lack of odor or detection demonstrates that exposure in excess of established limits is not possible. Note that reliance on odor and recognition requires that a representative number of the workers within each SEG be capable of detecting the agent(s) in question.

Physical properties, as well as odor and recognition thresholds, are examples of how one can determine that agents are not in excess of established limits and in-depth exposure assessments and workplace monitoring are not required. If sensory perception of odors does occur, then workplace monitoring may be employed to demonstrate compliance with applicable limits, provided the source of the odors is continuous.

CONCLUSION

When performing exposure assessments, it is recognized that they should be conducted using a systematic and comprehensive approach to ensure hazards are controlled to the degree necessary for the protection of workers. Applying the same degree of rigor to **all** exposure assessments may not be beneficial in many cases. In situations where it can be demonstrated that exposures will not affect worker safety and health, comprehensive exposure assessments and workplace monitoring will generally not be warranted. When done properly, employing such an approach has the benefit of protecting workers from adverse health effects and complying with the intent of , while having the flexibility of focusing on more significant exposures as well as identifying under-recognized exposures.

The scenarios described in the preceding paragraphs represent methods of appropriately addressing low risk exposures. These approaches will allow occupational safety and health professionals to focus on exposures which have real, rather than perceived, hazards.

By grouping and sharing exposure assessments and workplace monitoring data, it may become apparent that there are many exposure scenarios across the complex which present no hazard to workers. It is likely that as experience is gained in documenting these situations, additional scenarios will be identified which can be institutionalized throughout the complex.

WASHINGTON GROUP INTERNATIONAL

DEFINITIONS

Action Level – The point, typically 50% of an established exposure limit, at which a worker's exposure is considered to be sufficient to warrant exposure monitoring and possibly control measures. Action levels are based on exposure limits established by DOE directly (i.e., beryllium), OSHA (Permissible Exposure Limits), and ACGIH (Threshold Limit Values®). On occasion, in the absence of formally recognized exposure limits, a chemical manufacturer may establish an exposure limit which can be used to develop an action level or an exposure limit can be inferred by analogy or be based on toxicity information available in recognized sources. Where exposure limits differ, the most conservative value will normally be used to determine an action level. Typically, NIOSH Recommended Exposure Limits are not used to determine action levels.

Exposure – The inhalation, ingestion, absorption, injection, or contact with a chemical, biological, or physical agent.

Hazard – A chemical, biological, or physical agent that has the capability of producing injury, illness, or death to a worker. The more toxic an agent, and the greater the exposure, the greater the hazard.

Risk – The impact of the exposure of an agent on a worker. If a worker's exposure, appropriately weighted over time, exceeds an established exposure limit with some defined probability (for example more than 5 occasions in 100), the exposure must be controlled. Conversely, if a worker's exposure, appropriately weighted over time, does not exceed an established exposure limit, then the risk from the exposure is considered to be acceptable.

Sampling – Collecting a volume of air to determine the concentration of a chemical or biological agent in a workplace. For physical agents, the concentration in units applicable to the agent.

Task – For purposes of Workplace Evaluation and Setting Priorities, a job or portion of a job involving a discrete agent or set of agents to which workers are exposed.

Toxicity – The relative property of a chemical agent that refers to an adverse effect on workers. Typically, an agent's toxicity, when comparisons are made between the same test animal using the same end point, is considered to be objective.

REFERENCES

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