Evaluation of Noise and Metal Exposure at a Security Portal Manufacturer

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Contents

The employer is required to post a copy of this report for 30 days at or near the workplace(s) of affected employees. The employer must take steps to ensure that the posted report is not altered, defaced, or covered by other material.

The cover photo is a close-up image of sorbent tubes, which are used by the HHE Program to measure airborne exposures. This photo is an artistic representation that may not be related to this Health Hazard Evaluation. Photo by NIOSH.

Highlights of this Evaluation

The Health Hazard Evaluation Program received a request from a security portal manufacturing facility. The employer was concerned about employees' exposure to dust and noise when they sanded and sawed aluminum alloy.

What We Did

- We visited the facility in January 2016.
- We collected bulk dust samples in the fabrication area to screen for metals.
- We collected personal samples for respirable aluminum, total metals, and noise on fabrication area employees.
- We measured the size of airborne particles in the fabrication and office areas.
- We observed the airflow around the downdraft table in the sanding area.
- We observed employees' personal protective equipment use.

We were asked to evaluate employees' exposures to metal dust and noise in the fabrication areas. Employees were not overexposed to aluminum or other metals. Sanders and the mill/saw operator were overexposed to noise over an 8-hour work shift. However, employees typically performed these tasks for only 2–3 hours per shift. We recommend re-evaluating noise exposure during a typical work shift and whenever production changes.

What We Found

- Bulk dust samples contained mostly aluminum, chromium, manganese, and nickel.
- Employees sanding, assembling, and operating the mill/saw were not overexposed to aluminum, chromium, manganese, and nickel.
- Two sanders and the mill/saw operator were overexposed to noise.
- Employees in the electronics and assembly areas near the mill/saw were unnecessarily exposed to noise.
- The employer did not provide employees with Appendix D of the Occupational Safety and Health Administration respiratory protection standard for voluntary respirator use.
- We saw an employee improperly wearing an N95 filtering facepiece respirator.
- One employee stood in an awkward posture when sanding aluminum pieces on a downdraft table.

What the Employer Can Do

- Enclose the band saw area and make other changes to reduce noise exposure.
- Re-evaluate employee's noise exposures under typical sanding and sawing production levels and whenever fabrication processes change.

- Provide employees with Appendix D of the Occupational Safety and Health Administration respiratory protection standard for voluntary respirator use.
- Redesign the sanding tasks to lessen employees having to work in awkward positions.
- Create a health and safety committee with employer and employee representatives.
- Ask employees to report any symptoms they consider to be work-related to their supervisor and personal physician.

What Employees Can Do

- Use hearing protection when sanding and while the band saw is in operation.
- Participate in the health and safety committee.
- Take breaks from a task if you feel discomfort.
- Report any symptoms you believe to be work-related to your supervisor and personal physician.

Abbreviations

µg/m^3	Micrograms per cubic meter of air
AL	Action level
ACGIH®	American Conference of Governmental Industrial Hygienists
CFR	Code of Federal Regulations
dBA	Decibels, A-weighted
Hz	Hertz
NIHL	Noise-induced hearing loss
NIOSH	National Institute for Occupational Safety and Health
OEL	Occupational exposure limit
OSHA	Occupational Safety and Health Administration
PEL	Permissible exposure limit
REL	Recommended exposure limit
TLV®	Threshold limit value
TWA	Time-weighted average

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Introduction

The Health Hazard Evaluation Program received a request for an evaluation from a security portal manufacturing company. The employer was concerned that the noise and dust produced from sanding aluminum alloy and the noise generated from sawing alloy could be a health hazard to employees. We visited the company in January 2016. After the visit, we sent letters to the company and employee representative summarizing our activities.

Process Description

The workplace included a fabrication area and an office area with a conference room. At the time of the evaluation the employer planned to relocate the company in the next few months. Seven fabrication area employees worked 8-hour shifts from 6:30 a.m. to 3:00 p.m. The amount of aluminum fabricated depended on the design and size of each custom security portal, which are interlocking security door systems that are used in buildings requiring increased security including banking institutions, detention centers, and secure government buildings. All employees were cross-trained to do different jobs, such as sanding, milling, sawing, and assembling. Only one or two jobs were performed at the same time.

Aluminum fabrication began by sawing 24-foot long hollow aluminum alloy “sticks” with an automatic scissor-style band saw into shorter lengths (Figure 1). The width and depth of the sticks varied from 1 inch by 0.5 inch to 6 inches by 6 inches. After sawing the sticks, employees milled and sanded the surfaces in preparation for painting. Sanding was typically done for 2–3 hours per day for no more than 8–10 hours per week. Sanded aluminum pieces were sent out for painting by a contractor, then returned to the company for final assembly into custom-designed security portals. For large portals some processes such as milling and sanding were outsourced before returning to the company for final assembly.

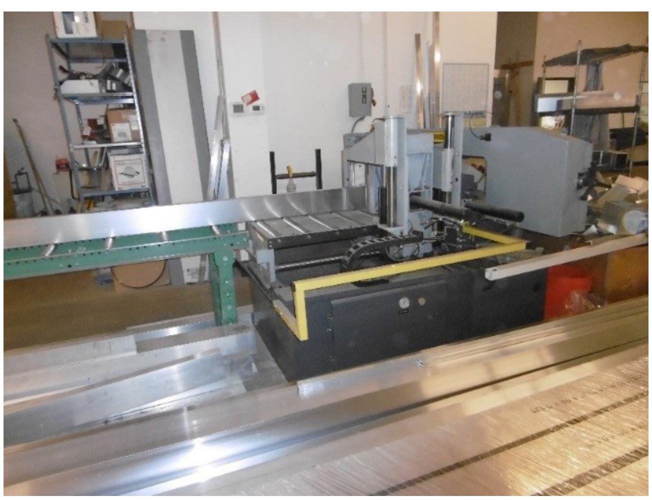

Figure 1. Automated band saw sawing a stick of aluminum alloy. The operating station is to the right of the saw. Photo by NIOSH.

During our visit, two employees sanded aluminum pieces for the entire 8-hour work shift (Figure 2), and one employee milled for half of the work shift and operated the band saw for the remainder of the work shift. Management adjusted their work practices for an 8-hour work shift to set up a worst-case scenario, where sanding occurred for the maximum time of 8 hours.

Figure 2. Employees power-sanding aluminum pieces on a downdraft table. Photo by NIOSH.

Methods

The objectives of this evaluation were to determine (1) if the dust generated during sanding presents a potential health hazard, (2) if there are other workplace exposures of concern, such as noise, and (3) if the ventilation system and downdraft table is adequate for the industrial processes performed at the facility.

Workplace Observations and Ventilation Assessment

We observed fabrication processes, work practices, workplace conditions, and personal protective equipment use. We used ventilation smoke tubes to observe airflow at the downdraft work table. We measured airborne particle size and number throughout the fabrication area and in the office area (for comparison) using an ARTI/Met One HHPC-6 mobile particle counter.

Bulk Dust and Air Sampling

During the site visit, we reviewed the safety data sheet the employer provided for the aluminum alloy. We collected bulk dust samples from inside the vacuum sander filter bag, inside the downdraft table bag filter, and settled dust from work surfaces in the sanding area and in the electronics area further away from the sanding area. The bulk dust samples were analyzed for elements (minerals and metals) using National Institute for Occupational Safety and Health (NIOSH) Method 7303 [NIOSH 2016a]. We used the results from the bulk sample analyses to select the elements to be analyzed in the air samples.

We collected personal air samples for respirable aluminum on four employees using NIOSH Method 7303 with modification using mixed cellulose ester membrane filters in 3-piece cassettes with a BGI Cyclone GK 2.69 [NIOSH 2016a]. The modification was wiping the interior of the cassette filter holder with a wet smear tab to collect particles on the inside walls. This practice is consistent with the current NIOSH recommendation that all particles entering the sampler be included as part of the sample whether they deposit on the filter or on the inside surfaces of the sampler [NIOSH 2016b]. We then analyzed the smear tab wipe along with the sample filter [NIOSH 2016b].

We collected and analyzed personal air samples for selected metals identified from the bulk dust samples using NIOSH Method 7303. This method uses a mixed cellulose ester filter with Solu-CAP cassette inserts. Use of the inserts eliminated the need for wiping the interior of the sample cassette.

Noise Sampling

We used Larson Davis Spark™ 706RC integrating noise dosimeters to measure time-weighted average (TWA) personal noise exposure on five employees. The dosimeters simultaneously collected data on three different settings to compare noise measurements with the Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL), the OSHA action level (AL), and the NIOSH recommended exposure limit (REL).

We also measured real-time, instantaneous noise measurements with a Quest Technologies® Model 2400 Type II Sound Level Meter. The instrument was set to measure instantaneous noise levels between 70 and 140 decibels, A-weighted (dBA) on a slow response scale.

The criteria for calculating the OSHA AL include all noise exposure greater than or equal to 80 dBA. The criteria for calculating the OSHA PEL include all noise exposure greater than or equal to 90 dBA. Both the OSHA AL and the OSHA PEL uses a 5-decibel exchange rate. The criteria for calculating the NIOSH REL include all noise exposure greater than or equal to 80 dBA, with a more conservative 3-decibel exchange rate. When an employee left the workplace during breaks, we stopped the noise dosimeters. We restarted them upon the employee's return.

Results and Discussion

Ventilation Assessment

An employee sanded aluminum pieces using a handheld random orbit electric sander equipped with a dust collection bag. The sanding was done on a downdraft ventilated work table. Airflow patterns observed using the ventilation smoke tubes showed that the downdraft table was not as effective in capturing airborne dust when sanding on either end of the table compared to the middle. The capture effectiveness also decreased as the sanding occurred further above the surface of the downdraft table, and might not be sufficient if the metal piece is tall.

Employees could not recall the last time the downdraft table filters were changed or replaced. The company had just received replacement filters for the downdraft table. When the downdraft table was opened for filter change, we noted a hole in one of the fabric filter bags. After the filter bag was replaced the dust capture effectiveness of the table appeared to improve on the basis of visual observations using smoke tubes. We contacted the manufacturer to inquire about downdraft table and dust types and consulted with the downdraft table owner's manual. According to the manufacturer the downdraft table was designed for wood dust; the manufacturer advised against using it for metal dust. Metal and wood dust differ in properties such as specific gravity and flammability. The designed capture velocity of the downdraft table 6 inches above the table is 673 feet per minute, and 12 inches above the table is 229 feet per minute. The American Conference of Governmental Industrial Hygienists (ACGIH) recommends capture velocities of 500–2,000 feet per minute for "grinding" tasks [ACGIH 2016b].

Airborne particle counts, for particles ranging from 0.3 to 10 micrometers in size, were consistently higher in the fabrication area than in the conference room (Table A1, Appendix A). Particle counts of all sizes increased in the afternoon compared to the morning in the fabrication area and the conference room. This could be due to several reasons. At 12:30 p.m., before the afternoon measurements, milling ceased and sawing began; this shift in processes could have changed the amount and size distribution of the dust particles produced. The downdraft table filter was changed before the lunch break at 11:30 a.m. It is possible that dust dispersed to other fabrication areas during the removal, emptying, and moving of the bag filter. Furthermore, the new filter could be less efficient at filtering out dust particles without a layer of built-up dust because efficiency increases with dust loading. The employer reported the office space was served by two separate heating, ventilating, and air-conditioning systems. Because our focus was on aluminum dust and noise exposures in the fabrication area we did not evaluate the heating, ventilating, and air-conditioning systems for the front administrative offices. If the units' supply air to offices was drawn from inside the building, a potential may exist for introducing dust from fabrication areas into the office.

Bulk Dust and Air Sampling

We analyzed for 32 elements in the bulk dust samples. From these results, we selected the metals that were present in the highest concentrations or have low occupational exposure limits (OELs) for analysis in the personal air samples. These included aluminum, arsenic, cadmium, chromium, lead, manganese, and nickel. The results of personal air sampling for metals are in Table 1. The three metals that were not detected along with their minimum detectable concentrations are: arsenic (< 0.6 micrograms per cubic meter [$\mu g/m^3$]), cadmium (< 0.2 $\mu g/m^3$), and lead (< 0.2 $\mu g/m^3$). For the metals that were detected, air sample results were compared to their respective NIOSH RELs, ACGIH threshold limit values (TLVs), and OSHA PELs. The personal air sampling results for all metals were well below their most protective OELs. Appendix B contains more information on OELs and health effects for substances we evaluated.

Table 1. Personal air sample results for total aluminum, chromium, manganese, and nickel, January 2016

Job title	Sample time (minutes)	Total aluminum (µg/m³)	Chromium (µg/m³)	Manganese (µg/m³)	Nickel (µg/m³)
Sander 1	501	850	0.50	1.4	0.20
Sander 2	503	930	0.49	0.64	0.12
Assembly	488	31	ND	0.067	[0.046]†
Mill operator/saw operator*	401	25	ND	0.068	ND
NIOSH REL		10,000	500	1,000	15
ACGIH TLV		None	500	100	1,500
OSHA PEL		15,000	1,000	5,000‡	1,000
Minimum detectable concentration		1	0.05–0.06	0.01	0.02–0.03
Minimum quantifiable concentration		3.2–4.0	0.15–0.19	0.024–0.031	0.083–0.11

ND = not detected, below the minimum detectable concentration

*This employee left work during breaks. The sampling pump was stopped when the employee left and restarted when the employee returned.

†This value is between the minimum detectable concentration and the minimum quantifiable concentration, meaning there is more uncertainty associated with this value.

‡A ceiling limit that should not be exceeded at any time.

The results of the personal air samples for respirable aluminum are presented in Table 2. The highest personal exposure was less than 20 µg/m³, well below the most protective OEL of 1,000 µg/m³.

Table 2. Personal air sample results for respirable aluminum, January 2016

Job title	Sample time (minutes)	Sample volume (liters)	Respirable aluminum (µg/m³)
Sander 1	501	2,108	15
Sander 2	503	2,117	20
Assembly	488	2,059	5.3
Mill operator/Saw operator*	401	1,680	5.0
NIOSH REL			5,000
ACGIH TLV			1,000
OSHA PEL			5,000

*This employee left work during breaks. The sampling pump was stopped when the employee left and restarted when the employee returned.

The highest metal exposures were measured on the two sanders. Although results were below applicable OELs, improving housekeeping and increasing the frequency of air filter replacement may further reduce unnecessary exposure to metal dust.

Noise Exposure and Hearing Conservation

Full-shift TWA personal dosimetry measurements are shown in Table 3. Noise exposures for both sanders and the mill/saw operator exceeded the NIOSH REL of 85 dBA for an 8-hour TWA. One of the sander's noise exposure also exceeded the OSHA AL of 85 dBA. During our evaluation, employees sanded for the entire work shift; however sawing and sanding is typically done for only 2 to 3 hours per day (8 to 10 hours per week). Because employees rarely saw and sand for a full work shift, on typical workdays their 8-hour TWA exposures would likely be lower than what we measured. However, on the basis of our measurements, the mill/band saw operator's noise exposure would exceed the NIOSH REL after 2.8 hours and the sanders' noise exposures would exceed the NIOSH REL after about 4.5 hours of sanding. The sanders' noise exposure would exceed the OSHA AL after 5.7 hours of sanding. Additionally, the band saw was used for the second half of the work shift while sanding also occurred. The employer has advised employees not to sand and saw at the same time to reduce cumulative noise from both noisy tasks.

Table 3. Personal noise sampling results, January 2016

Job title	Time (minutes)	Using NIOSH REL criteria (dBA)	Using OSHA AL criteria (dBA)	Using OSHA PEL criteria (dBA)
Mill operator/saw operator*	407	**89.5**	80.9	79.3
Sander 1	500	**87.4**	**85.2**	80.1
Sander 2	501	**85.9**	83.5	76.7
Electronics/assembly	456	76.2	66.9	56.6
Assembly	486	74.1	66.2	51.7
OELs, as 8-hour TWAs		85	85	90

Noise exposures exceeding the NIOSH REL or the OSHA AL are shown in bold text.

The noise levels reached 115 dBA in the hearing zone of the saw operator during operation and 112 dBA in nearby fabrication areas approximately 10 feet away from the band saw. When the band saw was not in operation, the noise levels ranged from 68 dBA to 89 dBA in the surrounding areas. These measurements show how the sawing operations affects noise exposures among nearby employees in the fabrication area.

The company did not have a hearing conservation program, but hearing protection was available and worn voluntarily. During our evaluation employees sanding wore foam insert ear plugs, and the employee operating the band saw wore earmuffs. Hearing protection appeared to be worn correctly and consistently throughout the work shift.

Other Observations

We saw two employees of different heights sanding aluminum pieces at the downdraft table (Figure 2). The taller employee bent his neck downward while sanding. Awkward work postures, such as bending the back or the neck, for prolonged periods can result in muscle fatigue, pain, or musculoskeletal disorders [OSHA 2000]. For this employee, a work surface that was raised or tilted toward the employee or an adjustable stool could reduce the need for awkward work postures. The height of the downdraft table was not adjustable.

Sanding employees voluntarily wore N95 filtering facepiece respirators but had not been provided with Appendix D of the OSHA 1910.134 respiratory protection standard. We saw some employees incorrectly wearing respirators. For example, an employee wore an N95 respirator with only the top strap secured. This employee also had facial hair in the area of the seal that would interfere with a proper face seal and reduce the protection offered by the respirator. Unused N95 respirators were stored in an open box near the sanding area; thus, they could become contaminated.

The employer stated that employees had once consumed food and drink in the fabrication area, but that this practice had stopped prior to our visit. The formation of a health and safety committee would help to facilitate communication about company policies and general hygiene practices. At the time of our site visit, the formation of an employee-employer health and safety committee was in progress.

Since the conclusion of the site visit, the company relocated its production operations.

Conclusions

Employees were overexposed to noise when sanding, milling, and sawing over an 8-hour work shift. However, because these work tasks are typically performed for only 2–3 hours per shift, employee noise exposures should be reevaluated. Fabrication employees near the milling/sawing operation were unnecessarily exposed to noise. Employees were not overexposed to respirable and total aluminum, or chromium, manganese, and nickel, but metal dust exposures may be further reduced by improving housekeeping and other work practices, such as frequently maintaining and checking downdraft table filters, using wet cleaning methods, and storing respirators away from the contamination source. If voluntary respirator use is allowed by the employer, employees should be provided with Appendix D of the OSHA respiratory protection standard and receive training on voluntary respirator use.

Employees used awkward postures, a risk factor for work-related musculoskeletal disorders. These awkward postures should be reduced through engineering or administrative controls.

Recommendations

On the basis of our findings, we recommend the actions listed below. We encourage the security portal manufacturer to use an employee-management health and safety committee or working group to discuss our recommendations and develop an action plan. Those involved in the work can best set priorities and assess the feasibility of our recommendations for the specific situation at the security portal manufacturer.

Our recommendations are based on an approach known as the hierarchy of controls. This approach groups actions by their likely effectiveness in reducing or removing hazards. In most cases, the preferred approach is to eliminate hazardous materials or processes and install engineering controls to reduce exposure or shield employees. Until such controls are in place, or if they are not effective or feasible, administrative measures and personal protective equipment may be needed. We recommend the following:

Engineering Controls

Engineering controls reduce employees' exposures by removing the hazard from the process or by placing a barrier between the hazard and the employee. Engineering controls protect employees effectively without placing primary responsibility of implementation on the employee.

1. Enclose the band saw area to prevent unnecessary noise exposure to employees in the fabrication area who are not operating the saw.
2. Adjust the downdraft table height to reduce awkward postures by employees when sanding. Alternatively, provide height-adjustable stools so employees can be seated and adjust their position to avoid awkward postures.
3. Select and purchase a downdraft table designed for metal dust when it is time to replace the current downdraft table.

Administrative Controls

The term administrative controls refers to employer-dictated work practices and policies to reduce or prevent hazardous exposures. Their effectiveness depends on employer commitment and employee acceptance. Regular monitoring and reinforcement are necessary to ensure that policies and procedures are followed consistently.

1. Improve hazard communication training to ensure that all employees are knowledgeable about metal dust, noise, and ergonomic hazards, how these exposures affect their health, and what protective measures should be used to prevent exposures.
2. Re-evaluate noise exposure during typical working conditions and whenever work processes change. If noise exposures exceed the lowest occupational exposure limits, implement a hearing conservation program for employees considering that production levels may vary. The program should include annual audiometric testing and training.

More information on establishing a hearing loss prevention program can be found at http://www.cdc.gov/niosh/docs/98-126/pdfs/98-126.pdf, http://www.osha.gov/dts/osta/otm/noise/hcp/index.html, and http://www.osha.gov/Publications/osha3074.pdf.

3. Until the current downdraft table is replaced, establish a filter inspection and change-out schedule for the downdraft table.
4. Use wet cleaning methods or vacuums equipped with high-efficiency particulate air filters to clean floors and surfaces.
5. Require employees to take frequent breaks when doing tasks that are associated with awkward positions, or vary tasks between different employees.
6. Encourage good personal hygiene practices such as hand-washing after glove removal and before eating, drinking, and smoking to reduce the risk of ingesting metals.
7. Ask employees to report any symptoms they consider to be work-related to their supervisor and personal physician.

Personal Protective Equipment

Personal protective equipment is the least effective means for controlling hazardous exposures. Proper use of personal protective equipment requires a comprehensive program and a high level of employee involvement and commitment. The right personal protective equipment must be chosen for each hazard. Supporting programs such as training, change-out schedules, and medical assessment may be needed. Personal protective equipment should not be the sole method for controlling hazardous exposures. Rather, personal protective equipment should be used until effective engineering and administrative controls are in place.

1. Require employees to use hearing protection when sawing because of high noise levels during these tasks.
2. Provide hands-on training for employees on how to insert hearing protectors properly and the importance of proper hearing protector fit.
3. Provide employees who voluntarily wear respirators with Appendix D from the OSHA respiratory protection standard 1910.134 (Information for Employees Using Respirators When Not Required Under the Standard). Employees should be advised on the proper donning and use of respirators, and supervisors should monitor the proper use and wearing of respirators. If respirators are required in the future, ensure that the respiratory protection program meets all required elements in the OSHA respiratory protection standard.

Appendix A: Tables

Table A1. Particle counts by diameter (in micrometers)

Location	Time	0.3	0.5	1.0	3.0	5.0	10
Conference room	9:00 a.m.	3,444	1,268	861	138	79	22
	2:02 p.m.	31,033	5,856	1,891	201	91	15
Downdraft table	9:25 a.m.	11,591	4,292	2,380	411	328	90
	9:40 a.m.	11,274	3,981	2,167	413	372	144
	9:47 a.m.	11,066	3,942	2,185	439	432	167
	2:10 p.m.	81,529	16,300	4,949	729	626	224
Electronics assembly	10:05 a.m.	8,901	3,043	1,517	222	152	38
	2:15 p.m.	76,903	14,237	4,091	510	365	91
Assembly	10:12 a.m.	9,266	3,110	1,543	239	179	41
Mill	10:00 a.m.	13,295	3,774	1,454	187	121	23

Appendix B: Occupational Exposure Limits and Health Effects

NIOSH investigators refer to mandatory (legally enforceable) and recommended OELs for chemical, physical, and biological agents when evaluating workplace hazards. OELs have been developed by federal agencies and safety and health organizations to prevent adverse health effects from workplace exposures. Generally, OELs suggest levels of exposure that most employees may be exposed to for up to 10 hours per day, 40 hours per week, for a working lifetime, without experiencing adverse health effects. However, not all employees will be protected if their exposures are maintained below these levels. Some may have adverse health effects because of individual susceptibility, a pre-existing medical condition, or a hypersensitivity (allergy). In addition, some hazardous substances act in combination with other exposures, with the general environment, or with medications or personal habits of the employee to produce adverse health effects. Most OELs address airborne exposures, but some substances can be absorbed directly through the skin and mucous membranes.

Most OELs are expressed as a TWA exposure. A TWA refers to the average exposure during a normal 8- to 10-hour workday. Some chemical substances and physical agents have recommended short-term exposure limits or ceiling values. Unless otherwise noted, the short-term exposure limit is a 15-minute TWA exposure. It should not be exceeded at any time during a workday. The ceiling limit should not be exceeded at any time.

In the United States, OELs have been established by federal agencies, professional organizations, state and local governments, and other entities. Some OELs are legally enforceable limits; others are recommendations.

- The U.S. Department of Labor OSHA PELs (29 CFR 1910 [general industry]; 29 CFR 1926 [construction industry]; and 29 CFR 1917 [maritime industry]) are legal limits. These limits are enforceable in workplaces covered under the Occupational Safety and Health Act of 1970.
- NIOSH RELs are recommendations based on a critical review of the scientific and technical information and the adequacy of methods to identify and control the hazard. NIOSH RELs are published in the *NIOSH Pocket Guide to Chemical Hazards* [NIOSH 2010]. NIOSH also recommends risk management practices (e.g., engineering controls, safe work practices, employee education/training, personal protective equipment, and exposure and medical monitoring) to minimize the risk of exposure and adverse health effects.
- Other OELs commonly used and cited in the United States include the TLVs, which are recommended by the ACGIH, a professional organization, and the workplace environmental exposure levels, which are recommended by the American Industrial Hygiene Association, another professional organization. The TLVs and workplace environmental exposure levels are developed by committee members of these associations from a review of the published, peer-reviewed literature. These OELs are not consensus standards. TLVs are considered voluntary exposure guidelines for use by industrial hygienists and others trained in this discipline "to assist in the control of health hazards" [ACGIH 2016a]. Workplace environmental exposure levels have

been established for some chemicals "when no other legal or authoritative limits exist" [AIHA 2016].

Outside the United States, OELs have been established by various agencies and organizations and include legal and recommended limits. The Institut für Arbeitsschutz der Deutschen Gesetzlichen Unfallversicherung (Institute for Occupational Safety and Health of the German Social Accident Insurance) maintains a database of international OELs from European Union member states, Canada (Québec), Japan, Switzerland, and the United States. The database, available at http://www.dguv.de/ifa/gestis/gestis-internationale-grenzwerte-fuer-chemische-substanzen-limit-values-for-chemical-agents/index-2.jsp, contains international limits for more than 2,000 hazardous substances and is updated periodically.

OSHA requires an employer to furnish employees a place of employment free from recognized hazards that cause or are likely to cause death or serious physical harm [Occupational Safety and Health Act of 1970 (Public Law 91–596, sec. 5(a)(1))]. This is true in the absence of a specific OEL. It also is important to keep in mind that OELs may not reflect current health-based information.

When multiple OELs exist for a substance or agent, NIOSH investigators generally encourage employers to use the lowest OEL when making risk assessment and risk management decisions. NIOSH investigators also encourage use of the hierarchy of controls approach to eliminate or minimize workplace hazards. This includes, in order of preference, the use of (1) substitution or elimination of the hazardous agent, (2) engineering controls (e.g., local exhaust ventilation, process enclosure, dilution ventilation), (3) administrative controls (e.g., limiting time of exposure, employee training, work practice changes, medical surveillance), and (4) personal protective equipment (e.g., respiratory protection, gloves, eye protection, hearing protection). Control banding, a qualitative risk assessment and risk management tool, is a complementary approach to protecting employee health. Control banding focuses on how broad categories of risk should be managed. Information on control banding is available at http://www.cdc.gov/niosh/topics/ctrlbanding/. This approach can be applied in situations where OELs have not been established or can be used to supplement existing OELs.

Metal Dust

Fine metal dusts produced from mechanical processes such as sanding, grinding, and milling can represent a health and safety hazard. Dusts can enter the body through inhalation, ingestion, and skin absorption. Depending on the properties of the metal dust (size, shape, and composition), exposure can be associated with health risks ranging from irritation to pneumoconiosis or cancer. Exposures to metal dust may be acute, occurring in a short time period, or chronic, occurring over months or years. Chronic occupational exposure to aluminum dust above the applicable exposure limits may cause pulmonary fibrosis, respiratory irritation, cough, and sore throat [Smolkova and Nakladalova 2014].

Metal dust also presents an explosion hazard when it is combustible. For example, airborne aluminum powder can explode [Khambekar and Pittenger 2013]. For a combustible dust to explode, there must be fuel (the combustible dust), an oxidizer, an ignition source, dust dispersion in a sufficient concentration, and confinement of the dust cloud.

Aluminum

Wheezing, dyspnea, and impaired lung function have been observed in workers chronically exposed to fine aluminum dust at much higher concentrations than were measured in this evaluation [Kongerud and Samuelson 1991]. Occupational asthma has also been associated with chronic exposure to aluminum [Abramson et al. 1989; Kilburn 1998]. Pulmonary fibrosis is the most commonly reported respiratory effect observed in workers exposed to fine aluminum dust, although there are conflicting reports on the fibrogenic potential of aluminum [ATSDR 2008].

Noise

Noise-induced hearing loss (NIHL) is an irreversible condition that progresses with noise exposure. It is caused by damage to the nerve cells of the inner ear and, unlike some other types of hearing disorders, cannot be treated medically [Berger et al. 2003]. More than 22 million U.S. workers are estimated to be exposed to workplace noise levels above 85 dBA [Tak et al. 2009]. NIOSH estimates that workers exposed to an average daily noise level of 85 dBA over a 40-year working lifetime have an 8% excess risk of material hearing impairment. This excess risk increases to 25% for an average daily noise exposure of 90 dBA [NIOSH 1998]. NIOSH defines material hearing impairment as an average of the hearing threshold levels for both ears that exceeds 25 dB at frequencies of 1,000 Hertz (Hz), 2,000 Hz, 3,000 Hz, and 4,000 Hz.

Although hearing ability commonly declines with age, exposure to excessive noise can increase the rate of hearing loss. In most cases, NIHL develops slowly from repeated exposure to noise over time, but the progression of hearing loss is typically the greatest during the first several years of noise exposure. NIHL can also result from short-duration exposures to high noise levels or even from a single exposure to an impulse noise or a continuous noise, depending on the intensity of the noise and the individual's susceptibility to NIHL [Berger et al. 2003]. Noise-exposed workers can develop substantial NIHL before it is clearly recognized. Even mild hearing losses can impair a person's ability to understand speech and hear many important sounds. In addition, some people with NIHL also develop tinnitus. Tinnitus is a condition in which a person perceives sound in one or both ears, but no external sound is present. Persons with tinnitus often describe hearing ringing, hissing, buzzing, whistling, clicking, or chirping like crickets. Tinnitus can be intermittent or continuous and the perceived volume can range from soft to loud. Currently, there is no cure for tinnitus.

The preferred unit for reporting of noise measurements is the dBA. A-weighting is used because it approximates the "equal loudness perception characteristics of human hearing for pure tones relative to a reference of 40 dB at a frequency of 1,000 Hz" and is considered to provide a better estimation of hearing loss risk than using unweighted or other weighting measurements [Earshen 2003].

Employees exposed to noise should have baseline and yearly hearing tests to evaluate their hearing thresholds and determine whether their hearing has changed over time. Hearing testing should be done in a quiet location, such as an audiometric test booth where background noise does not interfere with accurate measurement of hearing thresholds. In workplace hearing conservation programs, hearing thresholds must be measured at 500 Hz, 1,000 Hz, 2,000 Hz, 3,000 Hz, 4,000 Hz, and 6,000 Hz. Additionally, NIOSH recommends testing at 8,000 Hz [NIOSH 1998]. The OSHA hearing conservation standard requires analysis of changes from baseline hearing thresholds to determine if the changes are substantial enough to meet OSHA criteria for a standard threshold shift. OSHA defines a standard threshold shift as a change in hearing threshold (relative to the baseline hearing test) of an average of 10 dB or more at 2,000 Hz, 3,000 Hz, and 4,000 Hz in either ear [29 CFR 1910.95]. If a standard threshold shift occurs, the company must determine if the hearing loss also meets the requirements to be recorded on the OSHA Form 300 Log of Work-Related Injuries and Illnesses [29 CFR 1904.1]. In contrast to OSHA, NIOSH defines a significant threshold shift as a change in the hearing threshold level of 15 dB or more (relative to the baseline hearing test) at any test frequency in either ear measured twice in succession [NIOSH 1998].

NIOSH has an REL for noise of 85 dBA, as an 8-hour TWA. For calculating exposure limits, NIOSH uses a 3-dB time/intensity trading relationship, or exchange rate. Using the NIOSH criterion, an employee can be exposed to 88 dBA for no more than 4 hours, 91 dBA for 2 hours, 94 dBA for 1 hour, 97 dBA for 0.5 hours, etc. Exposure to impulsive noise should never exceed 140 dBA. For extended work shifts NIOSH adjusts the REL to 84.5 dBA for a 9-hour shift, 84.0 dBA for a 10-hour shift, 83.6 dBA for an 11-hour shift, and 83.2 dBA for a 12-hour work shift. NIOSH recommends the use of hearing protection and implementation of a hearing loss prevention program when noise exposures exceed the REL [NIOSH 1998].

The OSHA noise standard specifies a PEL of 90 dBA and an AL of 85 dBA, both as 8-hour TWAs. OSHA uses a less conservative 5-dB exchange rate for calculating the PEL and AL. Using the OSHA criterion, an employee may be exposed to noise levels of 95 dBA for no more than 4 hours, 100 dBA for 2 hours, 105 dBA for 1 hour, 110 dBA for 0.5 hours, etc. Exposure to impulsive or impact noise must not exceed 140 dB peak noise level. OSHA does not adjust the PEL for extended work shifts. However, the AL is adjusted to 84.1 dBA for a 9-hour shift, 83.4 dBA for a 10-hour shift, 82.7 dBA for an 11-hour shift, and 82.1 dBA for a 12-hour work shift. OSHA requires implementation of a hearing conservation program when noise exposures exceed the AL [29 CFR 1910.95].

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