Assessment of Peracetic Acid Exposure Among Federal Poultry Inspectors

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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 management representatives of the Employee Safety, Health, and Wellness Department, United States Department of Agriculture Food Safety and Inspection Service. They were concerned about federal inspectors' exposures to peracetic acid at a poultry production plant.

What We Did

- We visited the poultry production plant in September 2014.
- We observed work practices.
- We interviewed all six federal inspectors about their work, their health, and their concerns.
- We reviewed occupational safety and health records.
- We evaluated the ventilation in the evisceration area.
- We took air samples for peracetic acid, hydrogen peroxide, and acetic acid.

We evaluated exposures to peracetic acid, hydrogen peroxide, and acetic acid. We found low concentrations of acetic acid and hydrogen peroxide in the evisceration department and surrounding areas. We did not find peracetic acid in the air samples. Some employees reported occasional eye and throat irritation.

What We Found

- We found low levels of acetic acid and hydrogen peroxide in the large chiller area. We also found low levels of acetic acid in the evisceration area. We detected no peracetic acid in the air samples. None of the samples exceeded any occupational exposure limits.
- We found standing water on the roof around an evisceration department exhaust fan. We also found gaps in the exhaust fan flashing that could allow water to enter the building.
- Some employees reported occasional eye and throat irritation. These symptoms can be caused by exposure to chemicals used in the plant.
- We observed that the employees were wearing laboratory coats that did not cover their arms completely. This practice could expose them to chemicals and infectious agents.

What the Employer Can Do

- Review evacuation plans in case of accidental release of concentrated chemicals. Coordinate with plant managers.
- Provide training on the hazardous chemicals used in this workplace.
- Ensure that employees have the required personal protective equipment including eye and skin protection. Train employees on its use.
- Provide information to employees about the requirements for voluntary use of respirators.

- Encourage plant managers to repair the roof and maintain the flashing.

What Employees Can Do

- Wear required personal protective equipment.
- Report workplace health concerns to your employer.

Abbreviations

ACGIH®	American Conference of Governmental Industrial Hygienists
CFR	Code of Federal Regulations
FSIS	Food Safety and Inspection Service
MDC	Minimum detectable concentration
MQC	Minimum quantifiable concentration
NIOSH	National Institute for Occupational Safety and Health
OEL	Occupational exposure limit
OSHA	Occupational Safety and Health Administration
PEL	Permissible exposure limit
ppm	Parts per million
REL	Recommended exposure limit
STEL	Short-term exposure limit
TLV®	Threshold limit value
TWA	Time-weighted average
USDA	United States Department of Agriculture
WEEL™	Workplace environmental exposure level

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Introduction

The Health Hazard Evaluation Program received a request from the Employee Safety, Health, and Wellness Department, United States Department of Agriculture Food Safety and Inspection Service (USDA/FSIS). The request concerned potential exposures of USDA/FSIS employees at a poultry production plant to peracetic acid. In September 2014, we evaluated the evisceration area of the poultry plant. We provided a letter detailing our evaluation and preliminary recommendations in October 2014 and a summary of air monitoring results in December 2014. We sent these letters to the poultry company, USDA/FSIS managers, and USDA/FSIS employee union representatives. In December 2014, we provided individual air monitoring results to each employee we sampled.

The plant produced ready-to-cook whole chickens and parts. During our evaluation, the poultry plant processed approximately 38,000 birds per day. The birds weighed an average of 5.5 pounds. The plant had one evisceration line where the on-line federal inspectors checked birds for signs of infection or other defects. The plant operated one slaughter shift daily. Five USDA/FSIS employees worked this shift. Three were on-line inspectors in the evisceration area, one was a consumer safety inspector, and one was a public health veterinarian. The evisceration line operated at an average line speed of 91 birds per minute. The maximum line speed allowed by USDA/FSIS regulations given plant configuration and number of inspectors at the time of our evaluation was 105 birds per minute. Required personal protective equipment for USDA/FSIS employees on the evisceration line included a hard hat, hair net, nitrile gloves, hearing protection (insert-type plugs), fluid resistant apron, and non-slip rubber boots (Figure 1). Laboratory coats were available.

Figure 1. FSIS poultry inspector examining chicken carcass. Photo by NIOSH.

Perasafe™ (manufactured by AFCO) was used in the large 33,000-gallon chiller tank next to the evisceration area. The formulation of Perasafe, according to the AFCO safety data sheet, was about 15% peracetic acid, 10% hydrogen peroxide, and 35% acetic acid. The concentrated solution was stored in drums in a chemical room behind the large chiller. Peracetic acid solution was piped into the chiller tank by maintenance staff when needed to maintain effective concentrations. The concentrated solution was mixed with water to reduce the concentration of peracetic acid to 200 parts per million (ppm). FSIS allows up to 2,000 ppm peracetic acid for use on food products [USDA 2015]. Plant employees used direct reading titration kits to test the concentration of peracetic acid and chlorine hourly. Chlorine was not used in the large chiller tank. Chlorine was used on the rework, liver, gizzard, and feet chiller lines for disinfection. These lines were not near the evisceration area.

Chlorine and the peracetic acid solution were the only two antimicrobial products used in processing at the time of our evaluation. No flavorings, breading, or other additives were used at the time of our evaluation.

Peracetic Acid, Acetic Acid, and Hydrogen Peroxide

Peracetic acid is formed from a sulfuric acid-catalyzed chemical reaction between acetic acid and hydrogen peroxide. Peracetic acid solutions typically consist of a mixture of peracetic acid, acetic acid, and hydrogen peroxide in various concentrations. Peracetic acid is used as a disinfectant in the biotechnology, food, healthcare, and pharmaceutical industries. In 2004, it was estimated that less than 20,000 tons of peracetic acid was used in the United States [Pechacek et al. 2015]. Peracetic acid may be present in particle and vapor phases, especially during spraying or fogging [ACGIH 2015b]. The American Conference of Governmental Industrial Hygienists (ACGIH) has established a threshold limit value-short-term exposure limit (TLV-STEL) of 0.4 ppm for peracetic acid measured as an inhalable fraction and vapor [ACGIH 2015a]. Neither the National Institute for Occupational Safety and Health (NIOSH) nor the Occupational Safety and Health Administration (OSHA) has established occupational exposure limits (OELs) for peracetic acid. Peracetic acid is considered volatile and has a pungent, vinegar-like odor. An unpublished Swedish report estimated the odor threshold as 0.05 ppm [Pechacek et al. 2015]. An acute exposure guideline of 0.17 ppm was recommended as a threshold for irritation among the general population [National Academy Press 2010].

Acute exposure to peracetic acid has been shown to cause irritation of the eyes, skin, and upper respiratory tract [New Jersey Department of Health and Senior Services 2004; Pechacek et al. 2015]. Peracetic acid is considered to be a stronger sensory irritant than acetic acid or hydrogen peroxide [National Academy Press 2010]. Asthma associated with peracetic acid exposure in healthcare workers has been reported [Cristofari-Marquand et al. 2007]. In 2006, NIOSH evaluated exposure to a peracetic acid sterilant (Steris® 20 Sterilant Concentrate) in a hospital endoscopy reprocessing department [NIOSH 2009]. The Steris concentrate was used in automated endoscopy reprocessing machines that occasionally malfunctioned; some employees reported headache, burning eyes, and skin burns that were more common during machine malfunction or when handling the concentrate without appropriate personal protective equipment. Most reported adverse events from exposure to the Steris 20 Sterilant were skin burns from exposure to the concentrated solution; however, shortness of breath and nasal irritation were also reported. Another NIOSH study found symptoms of watery eyes, nasal problems, asthma-like symptoms, and shortness of breath among employees working with peracetic acid disinfectant in a hospital [Hawley et al. 2016].

Acetic acid is used in many industrial processes and in the manufacture of vitamins, antibiotics, and as a food additive [Virginia Department of Health 1994]. Most types of vinegar are typically 4%–6% acetic acid. The odor threshold for acetic acid is typically 24 ppm. Acetic acid solution contact with eyes and skin can cause eye damage and skin irritation. Dilute acetic acid solutions have a low vapor pressure, which results in low inhalation exposures [ACGIH 2011]. NIOSH and OSHA have established OELs of 10 ppm [NIOSH 2010]. ACGIH has established a TLV of 10 ppm and a TLV-STEL of 15 ppm for acetic acid [ACGIH 2015a]. Acetic acid has not been shown to cause cancer in animal studies.

The OELs for hydrogen peroxide are based on the potential irritating effects to the eyes, skin, mucous membranes, and respiratory tract. NIOSH, OSHA, and ACGIH have established OELs of 1 ppm for hydrogen peroxide [NIOSH 2010; ACGIH 2015a]. A case report described diffuse interstitial lung disease and shortness of breath in a dairy plant worker exposed to hydrogen peroxide while operating a milk packing machine that used a hydrogen peroxide bath to disinfect milk cartons [Kaelin et al. 1988]. Hydrogen peroxide air concentrations were approximately 30 ppm near the machine and 9 ppm close to the floor, both well above OELs. All seven employees reported eye and throat irritation and the gradual bleaching of their hair. The affected employee's shortness of breath resolved without treatment 1.5 months after removal from exposure. A study among workers at a beverage processing plant where bottles were disinfected with a solution of hydrogen peroxide, acetic acid, and peracetic acid showed no significant changes in lung function over time at levels at or below the hydrogen peroxide OEL of 1 ppm [Mastrangelo et al. 2005]. ACGIH lists hydrogen peroxide as a "confirmed animal carcinogen with unknown relevance to humans" [ACGIH 2015]. No other agency has listed hydrogen peroxide as a carcinogen.

Methods

The objectives of this evaluation were to determine the extent of USDA/FSIS inspectors' exposures to peracetic acid and whether employees had potential work-related symptoms. We observed workplace conditions and work processes and practices. We reviewed illness and injury logs and held confidential medical interviews with USDA/FSIS employees. Because this was a USDA/FSIS management request, we did not interview the poultry plant employees. We offered to include plant employees in our evaluation, but plant managers declined. We examined the rooftop exhaust fans and looked at ventilation in the evisceration department. We reviewed how peracetic acid was added to the dip and chill tanks and the titration method used to verify its concentration.

We collected two personal air samples and three area air samples for acetic acid on charcoal tubes using OSHA Method PV2119 [OSHA 2015]. We took four area air samples for acetic acid (sampling range: 5 ppm to 80 ppm) and hydrogen peroxide (sampling range: 0.1 ppm to

3 ppm) using Draeger direct reading colorimetric indicator tubes. We collected 25 personal air samples and 4 area air samples for hydrogen peroxide and peracetic acid. Twenty-one of the personal air samples were collected on one of the inspectors for short periods throughout the shift. We combined these samples to create a full-shift sample of 388 minutes. The hydrogen peroxide and peracetic acid samples were taken at a flowrate of 1 liter per minute. The hydrogen peroxide samples were collected on treated filters (SKC #225-9030) and digested with sulfuric acid. The samples were centrifuged, and the extract was read using ultraviolet-visible spectrophotometry following an analytical method described by Hecht et al. [2004]. The peracetic acid samples were collected on silica gel tubes (SKC #226-193) and desorbed with acetonitrile. The samples were then diluted with deionized water. The solutions were analyzed using high-performance liquid chromatography according to an in-house method from the NIOSH contract laboratory based on the Hecht et al. method [2004]. The Hecht et al. method may underestimate exposures when peracetic acid is applied as a spray [2004].

Results and Discussion

Air Sampling

We combined 21 short duration personal air samples collected on one USDA/FSIS inspector to provide an estimate of the inspector's full-shift exposure to peracetic acid and hydrogen peroxide. The sample results, presented in Table 1, show that we did not detect peracetic acid or hydrogen peroxide in these samples. Only one of the two personal air samples for acetic acid had a detectable concentration of acetic acid and it was low (estimated as 0.03 ppm). This concentration was below any OELs. The results of four short-term personal air samples for peracetic acid and hydrogen peroxide collected on two inspectors are presented in Table 2. Peracetic acid and hydrogen peroxide were not detected in these samples. We did not observe sprays, droplets, or aerosolization of the solution in the work areas where we collected air samples for peracetic acid and hydrogen peroxide. Therefore, the analytical method should be a good approximation of peracetic acid and hydrogen peroxide vapor exposure.

Table 1. Concentrations of disinfection chemicals in work shift personal air samples from employees in the evisceration department, September 24, 2014

Job title	Sample duration (minutes)	Peracetic acid (ppm)*	Hydrogen peroxide (ppm)†	Acetic acid (ppm)‡
Inspector 1	388	ND	ND	NA
Inspector 2	252¶	NA	NA	[0.030]§
Inspector 3	200¶	NA	NA	ND
NIOSH REL	—	NA	1	10
OSHA PEL	—	NA	1	10
ACGIH TLV	—	NA	1	10

MDC = Minimum detectable concentration

MQC = Minimum quantifiable concentration

ND = Not detected

NA = Not applicable; no sample was taken

PEL = Permissible exposure limit

REL = Recommended exposure limit

*The MDC of peracetic acid was 0.04 ppm, and the MQC was 0.12 ppm using an average sample volume of 17.9 liters.

†The MDC of hydrogen peroxide was 0.08 ppm, and the MQC was 0.32 ppm using an average sample volume of 17.9 liters.

‡The MDC of acetic acid was 0.03 ppm, and the MQC was 0.11 ppm using an average sample volume of 24.1 liters.

§Concentrations in brackets are between the MDC and MQC, meaning there is more uncertainty associated with these results.

¶Because of work scheduling issues, these samples were collected for less than a full 8-hour shift. The work that was performed during the sampling time was reported by employees and the employer to be representative of a typical workday.

Table 2. Concentrations of disinfection chemicals in short-term, personal air samples from employees in the evisceration department, September 24, 2014

Job title	Sample duration (minutes)	Peracetic acid (ppm)*	Hydrogen peroxide (ppm)†
Inspector 2	16	ND	ND
Inspector 2	13	ND	ND
Inspector 3	17	ND	ND
Inspector 3	17	ND	ND
NIOSH REL	—	NA	NA
OSHA PEL	—	NA	NA
ACGIH TLV	—	0.4 STEL	NA

*The MDC of peracetic acid was 0.04 ppm, and the MQC was 0.12 ppm using an average sample volume of 17.9 liters.

†The MDC of hydrogen peroxide was 0.08 ppm, and the MQC was 0.32 ppm using an average sample volume of 17.9 liters.

We collected three area air samples for acetic acid near the large chiller tank (Table 3). The concentrations ranged from 0.03 ppm to 0.07 ppm. An additional four short-term area air samples collected around the large chiller tank did not have detectable concentrations of peracetic acid or hydrogen peroxide.

Table 3. Area air sample concentrations of acetic acid, September 24, 2014

Location	Sample duration (minutes)	Acetic acid (ppm)*
Back of large chiller	524	0.07
Front of large chiller	525	0.06
Start of evisceration line	399	[0.03]†

*The MDC of acetic acid was 0.02 ppm, and the MQC was 0.054 ppm based on an average sample volume of 50.2 liters.

†Concentrations in brackets are between the MDC and MQC, meaning there is more uncertainty associated with these results.

We collected three short-term direct reading air samples for acetic acid and hydrogen peroxide during normal production activities. The sample results, presented in Table 4, show that the concentration of H_2O_2 was 0.05 ppm behind the large chiller tank. All the other samples for hydrogen peroxide and acetic acid had non-detectable concentrations.

Table 4. Area air sample concentrations using colorimetric tubes, September 23, 2014

Location	Sample time	Hydrogen peroxide (ppm)	Acetic acid (ppm)
End of large chiller near rehang	11:01 a.m.	ND	ND
Behind large chiller	11:14 a.m.	0.05	ND
Evisceration line	11:24 a.m.	ND	ND

The limit of detection limits for the colorimetric tubes was 0.1 ppm for hydrogen peroxide and 5 ppm for acetic acid.

OSHA Evaluation Summary

OSHA did air sampling at the plant in June and August 2013. In June 2013, they collected area air samples for peracetic acid, hydrogen sulfide, chlorine, chloramines, and hydrogen peroxide. Two area air samples for peracetic acid collected near the large chiller had detectable concentrations (0.05 ppm and 0.06 ppm). The other chemicals were not detected. In August 2013, they collected personal air samples on the USDA/FSIS inspectors for peracetic acid, but found no detectable concentrations.

Observations

The processing plant did not have a ducted ventilation system. Natural ventilation from wall openings provided outdoor air. Two large exhaust fans in the evisceration room ceiling exhausted directly outside through the roof. The evisceration room also had two variable speed, large portable fans to provide air movement. The chemical room had a dedicated exhaust fan. Additionally, a large exhaust fan positioned directly over the chiller exhausted air directly outdoors. The airflow pattern went from clean areas to dirty areas. The fans did not blow air directly onto the employees or product.

The building had a flat tar membrane roof with dips that held water. The flashing around one of the large rooftop exhaust fans was peeled away and exposed the wood sub-roof. We found evidence of microbial growth in an old maintenance area that was no longer used and was not part of the production facility.

We observed the employees wearing the USDA/FSIS required personal protective equipment. However, the inspectors were wearing laboratory coats that did not cover their arms completely, which could lead to potential exposures to chemicals and infectious agents such as *Campylobacter*.

Employee Interviews and Record Reviews

We held confidential, voluntary medical interviews with all six USDA/FSIS inspectors who either worked at the plant full-time or who rotated shifts between this plant and other local slaughter establishments. We discussed prior injuries or illnesses related to work, current health status and symptoms, health history, and employee perceptions of communication, work organization, job stress, and other safety or health concerns. We reviewed Occupational Safety and Health Administration Form 300 Log of Work-Related Injuries and Illnesses for years 2009–2014 (through September) for USDA/FSIS employees.

Employee Interviews

Participants reported working for USDA/FSIS an average of 7.2 years (median 4 years); average length of employment at this plant was 4.4 years (median 1.5 years). Current health symptoms reported by some employees included occasional eye irritation, sore throat, headache, pain and numbness in the wrists, and sinus infections within the last month. Most employees either did not report any health symptoms or thought symptoms were not related to work, such as symptoms they related to seasonal allergies or non-work related injuries or conditions.

Health and Safety Concerns

We asked participants an open-ended question regarding what, if any, health and safety concerns they had about their job or workplace. Responses included concerns about the level of chemical hazard training provided by the employer and concerns about how peracetic acid and chlorine are diluted and incorporated into the production process. Additional concerns included poor ventilation/air movement in the vicinity of the chiller and the USDA/FSIS inspection stations. Some employees were concerned about eye splashes from chicken carcasses exiting the chiller and the potential short- and long-term health effects from exposure to peracetic acid. One employee stated they wore an N95 filtering facepiece respirator when working at their inspection station because of concerns about dust, feathers, and chemical exposures. We informed the employee that the N95 filtering facepiece respirator was appropriate for particle exposures and should not be used to control gas and vapor exposures.

Employees and the employer told us about an August 2014 accidental release of peracetic acid from a leak in the line that ran between the chemical storage room and the chiller. The plant was evacuated for about 90 minutes because of complaints of a strong vinegar-like odor, and respiratory and eye irritation and burning. Some employees felt that the employer should have evacuated the plant faster and more clearly communicated the reason for the evacuation to all employees.

Communication and Work Organization

We asked employees questions about workplace communication (communication between USDA/FSIS on-site managers and employees, USDA/FSIS managers and the union, and USDA/FSIS headquarters staff and employees). One employee reported concerns about communication with USDA/FSIS headquarters; no one else reported communication concerns between any of these groups. We also asked questions about whether the following were problems at work: workload or production speed, effectiveness of safety policies and procedures, scheduling and overtime, job stress, and job security. Two employees reported concerns about workload and production speed, specifically regarding the speed at which they were required to visually inspect bird carcasses. The pace of inspection resulted in job stress and conflict between USDA/FSIS employees and plant managers and employees. This situation occurred periodically when inspectors required the plant to decrease evisceration line speed in response to defects found in the carcasses. No one expressed concerns about scheduling, overtime, or job security.

Review of OSHA Logs

The OSHA Logs from 2009 to September 2014 contained reports of three injuries/illnesses, one each in the years 2011, 2012, and 2013. Reported events for USDA/FSIS employees included a *Salmonella* infection, a needlestick from a needle found in a chicken carcass, and an injury/fall. Total days away from work were 3.5.

Conclusions

We detected low concentrations of acetic acid and hydrogen peroxide in personal and area air samples taken in the evisceration area and in the large chiller area adjacent to the evisceration line. All of the concentrations we measured in personal air samples were well below OELs. Some employees reported occasional symptoms of eye and respiratory irritation. Although these symptoms can be caused by exposure to peracetic acid, acetic acid, and hydrogen peroxide, symptoms caused by these exposures are typically reported at concentrations much higher than we measured during our evaluation. In its concentrated form in the chemical storage room and before dilution in the chiller tank, the peracetic acid solution (Perasafe) is corrosive to skin and is a respiratory irritant.

Recommendations

On the basis of our findings, we recommend the actions listed below. We encourage USDA/FSIS to use a labor-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 poultry plant. We encourage USDA/FSIS to also work with plant management to address recommendations that involve ventilation and chemical handling.

Our recommendations are based on an approach known as the hierarchy of controls (Appendix A: Occupational Exposure Limits and Health Effects). 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.

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. Ensure that employee training programs regarding hazardous chemicals follow the OSHA hazard communication standard available at https://www.osha.gov/dsg/hazcom/. OSHA provides additional information in its “Hazard Communication: Small Entity Compliance Guide for Employers That Use Hazardous Chemicals” available at https://www.osha.gov/Publications/OSHA3695.pdf.
2. Encourage USDA/FSIS inspectors to continue reporting symptoms they experience to occupational safety and health specialists at USDA. Reporting allows for investigation of the specific conditions present when symptom frequency increases.
3. Ensure that the plant has emergency evacuation plans to allow the timely notification and evacuation of all employees. These plans should be tested periodically.

4. Ensure that the plant has an incident investigation program (root-cause analysis) for plant evacuations.
5. Encourage the plant to repair the dips found in the flat roof and the flashing around the large exhaust fan.

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. Request that the company place a barrier below the area where chicken carcasses exit the chiller to prevent eye splashes for all employees. If this is not feasible, provide inspectors in this area with chemical splash goggles.
2. Cover exposed skin on the arms with a laboratory coat or longer gloves to prevent potential dermal exposure to chemicals or infectious agents such as *Campylobacter*.
3. Provide training about the proper use of respirators and follow the OSHA respiratory protection standard [29 CFR 1910.134] regarding voluntary use of respirators. Provide Appendix D of the OSHA respiratory protection standard [29 CFR 1910.134] to employees using respirators voluntarily (https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9784).

Appendix A: Occupational Exposure Limits

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 time-weighted average (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 STEL or ceiling values. Unless otherwise noted, the STEL 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 ACGIH, a professional organization, and the workplace environmental exposure level (WEELs), which are recommended by the American Industrial Hygiene Association, another professional organization. The TLVs and WEELs 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 2015a]. WEELs have been established for some chemicals "when no other legal or authoritative limits exist" [AIHA 2015].

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-Stoffdatenbank/index-2.jsp, contains international limits for more than 1,500 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.

References

ACGIH [2011]. Documentation of the threshold limit values and biological exposure indices. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

ACGIH [2015a]. 2015 TLVs® and BEIs®: threshold limit values for chemical substances and physical agents and biological exposure indices. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

ACGIH [2015b]. Documentation of the threshold limit values and biological exposure indices: peracetic acid. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

AIHA [2015]. AIHA 2015 emergency response planning guidelines (ERPG) & workplace environmental exposure levels (WEEL) handbook. Fairfax, VA: American Industrial Hygiene Association.

CFR. Code of Federal Regulations. Washington, DC: U.S. Government Printing Office, Office of the Federal Register.

Cristofari-Marquand E, Kacel M, Milhe F, Magnan A, Lehucher-Michel MP [2007]. Asthma caused by peracetic acid-hydrogen peroxide mixture. J Occup Health *49*(2):155–158.

Hawley B, Casey ML, Cox-Ganser JM, Edwards N, Fedan KB, Cummings KJ [2016]. Notes from the field. Respiratory symptoms and skin irritation among hospital workers using a new disinfection product — Pennsylvania, 2015. MMWR *65*(15):400–401. [http://www.cdc.gov/mmwr/volumes/65/wr/mm6515a3.htm?s_cid=mm6515a3_e]. Date accessed: May 2016.

Hecht G, Héry M, Hubert G, Subra I [2004]. Simultaneous sampling of peroxyacetic acid and hydrogen peroxide in workplace atmospheres. Ann Occup Hyg *48*(8):715–721.

Kaelin R, Kapanci Y, Tschopp J [1988]. Diffuse interstitial lung disease associated with hydrogen peroxide inhalation in a dairy worker. Am Rev Respir Dis *137*(5):1233–1235.

Mastrangelo G, Zanibellato R, Fedeli U, Fadda E, Lange JH [2005]. Exposure to hydrogen peroxide at TLV level does not induce lung function changes: a longitudinal study. Int J Environ Health Res *15*(4):313–317.

National Academies Press [2010]. Chapter 7: peracetic acid-acute exposure guideline levels. In: acute exposure guideline levels for selected airborne chemicals: volume 8. [http://www.epa.gov/opptintr/aegl/pubs/peracetic_acid_final_volume8_2010.pdf]. Date accessed: May 2016.

New Jersey Department of Health and Senior Services [2004]. Hazardous substance fact sheet: peroxyacetic acid. Trenton, NJ: New Jersey Department of Health and Senior Services. [http://nj.gov/health/eoh/rtkweb/documents/fs/1482.pdf]. Date accessed: May 2016.

NIOSH [2009]. Health hazard evaluation report: evaluation of worker exposures to peracetic acid-based sterilant during endoscope reprocessing, Buffalo, NY. By Sylvain D, Gibbins J. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, NIOSH HHE Report No. 2006-0298-3090.

NIOSH [2010]. NIOSH pocket guide to chemical hazards. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2010-168c. [http://www.cdc.gov/niosh/npg/]. Date accessed: May 2016.

OSHA [2015]. Sampling and analytical methods. Salt Lake City, UT: U.S. Department of Labor, Occupational Safety and Health Administration, Salt Lake Technical Center. [https://www.osha.gov/dts/sltc/methods/index.html]. Date accessed: May 2016.

Pechacek N, Osorio M, Caudill J, Peterson B [2015]. Evaluation of the toxicity data for peracetic acid in deriving occupational exposure limits: a minireview. Toxicol Lett *233*(1):45–57.

USDA [2015]. Safe and suitable ingredients used in the production of meat, poultry, and egg products. Washington, DC: United States Department of Agriculture, Food Safety and Inspection Service. [http://www.fsis.usda.gov/wps/wcm/connect/bab10e09-aefa-483b-8be8-809a1f051d4c/7120.1.pdf?MOD=AJPERES]. Date accessed: May 2016.

Virginia Department of Health [1994]. Acetic acid fact sheet. [http://www.vdh.virginia.gov/epidemiology/DEE/PublicHealthToxicology/documents/pdf/aceticacid.PDF]. Date accessed: May 2016.

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Availability of Report

Copies of this report have been sent to the employer, employees, and union at the facility. The state and local health department and the Occupational Safety and Health Administration Regional Office have also received a copy. This report is not copyrighted and may be freely reproduced.

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