HealthHazard Evaluation Program

Evaluation of Indoor Environmental Quality at a State-Operated Wastewater Treatment Plant

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CDC NIOSH

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The Health Hazard Evaluation Program investigates possible health hazards in the workplace under the authority of the Occupational Safety and Health Act of 1970 [29 USC 669a(6)]. The Health Hazard Evaluation Program also provides, upon request, technical assistance to federal, state, and local agencies to investigate occupational health hazards and to prevent occupational disease or injury. Regulations guiding the Program can be found in Title 42, Code of Federal Regulations, Part 85; Requests for Health Hazard Evaluations [42 CFR Part 85].

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Introduction

Request

An employee representative from a state wastewater treatment plant requested a health hazard evaluation concerning indoor environmental quality. Employees were concerned about ventilation issues in the buildings housing the wastewater treatment operations, specifically the laboratory building, where employees spent most of their workday. Additional concerns included potential exposures to process chemicals, bacteria and other pathogens, and mold.

Workplace

Built in 1978, the wastewater plant treated, processed, and disposed of sewage from the adjacent state prison. It was designed to process 310,000 gallons a day but was only processing 80,000 gallons a day during our visit. Both of the employees assigned to the facility were on-site and working during our visit.

To learn more about the workplace, go to Section A in the Supporting Technical Information

Our Approach

Upon receiving the request, we spoke with employees to better understand their concerns. We also spoke with management to better understand policies and procedures in place at the facility. We reviewed written safety plans and other documents provided to us by management. We visited the workplace in June 2024 to learn more about the workplace environment where we did the following:

- Spoke with employees about work processes, daily work tasks, and work-related concerns.
- Observed work processes and workplace conditions.
- Visually inspected each buildings ventilation system(s).
- Collected direct reading measurements for hydrogen sulfide, volatile organic compounds, carbon monoxide, carbon dioxide, temperature, and relative humidity.

To learn more about our methods, go to Section B in the Supporting Technical Information

Our Key Findings

We found deficiencies and recent improvements in building ventilation systems

- The ventilation system in the Filter Building 22 was deteriorated and unrepairable.
- One return vent in the Sludge Building 21 was partially blocked by a light fixture.

- A mini-split system was recently installed in the laboratory. This system could control temperature and humidity, but could not provide outdoor air to, or exhaust air from the laboratory.
- Employees used several small space heaters to supplement building heating, ventilation, and air-conditioning (HVAC) systems.

Employees were exposed to untreated water and partially treated water

- The grinder used to break up debris splashed untreated water onto the employee walkway.
- The collection bowl used for retrieving quality check samples of return active sludge had the potential to splash partially treated water. The floor under the bowl was wet.

Employees were at risk for exposure to powdered lime

- Powdered lime spilled on an employee's personal protective equipment and clothing.

Employees were at risk of slips, trips, and falls

- A hatch door opened to remove stored treated sludge created an entry to a confined space and risk of accidental entry fall.
- Water accumulated on walkways inside and pooled outside the entry of the Sludge Building 21.

To learn more about our results, go to Section B in the Supporting Technical Information

Our Recommendations

The Occupational Safety and Health Act requires employers to provide a safe workplace.

Potential Benefits of Improving Workplace Health and Safety:

↑ Improved worker health and well-being	↑ Enhanced image and reputation
↑ Better workplace morale	↑ Superior products, processes, and services
↑ Easier employee recruiting and retention	↑ May increase overall cost savings

The recommendations below are based on the findings of our evaluation. For each recommendation, we list a series of actions you can take to address the issue at your workplace. The actions at the beginning of each list are preferable to the ones listed later. The list order is based on a well-accepted approach called the "hierarchy of controls." The hierarchy of controls 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 practical, administrative measures and personal protective equipment might be needed. Read more about the hierarchy of controls at https://www.cdc.gov/niosh/hierarchy-of-controls/about/index.html.

We encourage the company to use a health and safety committee to discuss our recommendations and develop an action plan. Both employee representatives and management representatives should be included on the committee. Helpful guidance can be found in *Recommended Practices for Safety and Health Programs* at https://www.osha.gov/safety-management.

Recommendation 1: Address ventilation deficiencies in process buildings.

Why? Properly designed, installed, and maintained HVAC systems improve workplace environments when they control comfort parameters (temperature, humidity). Maintaining comfort parameters at recommended levels has been shown to help improve or resolve symptoms among building occupants.

Although no comprehensive regulatory standards specific to indoor environmental quality have been established, guidelines have been developed by organizations and agencies, including the American National Standards Institute (ANSI)/ASHRAE, the National Institute for Occupational Safety and Health (NIOSH), and the Environmental Protection Agency (EPA). These resources are available from the NIOSH indoor environmental quality topic page at http://www.cdc.gov/niosh/topics/indoorenv/.

How? At your workplace, we recommend these specific actions:

Consult with a licensed professional mechanical engineer to conduct a comprehensive assessment of building ventilation systems.

- The licensed professional mechanical engineer should have experience in the design of HVAC systems for industrial settings like this wastewater treatment plant. Different processes will present different challenges to the HVAC system(s).
    - Table 6-1 of ANSI/ASHRAE Standard 62.1-2022 "Ventilation for Acceptable Indoor Air Quality" recommends a minimum ventilation rate of 10 cubic feet per minute per person for science laboratories. However, adequate ventilation rates can depend on occupancy, room size, outdoor air provided, and other building-related sources.
    - ANSI/ASHRAE Standard 55-2023 "Thermal Environmental Conditions for Human Occupancy" reports human comfort to temperature and humidity levels and establishes a range of temperatures and humidity levels that are considered comfortable by 80% or more of the test subjects. The standard recommends:

    - 68.5 degrees Fahrenheit to 76 degrees Fahrenheit in the winter, and 75 degrees Fahrenheit to 80.5 degrees Fahrenheit in the summer (assuming low air movement and 50% relative humidity)
    - Relative humidity be kept at or below 65% in all seasons.

- Ensure that the exhaust vents in the Sludge Building 21 do not interfere with the operation of the HVAC system(s).

Recommendation 2: Install controls and improve work practices to reduce exposure to untreated sewage.

Why? Exposure to untreated sewage can increase employee exposures to waterborne diseases. Examples of health outcomes include vomiting, stomach cramps and watery diarrhea (https://www.cdc.gov/global-water-sanitation-hygiene/about/workers_handlingwaste.html).

How? At your workplace, we recommend these specific actions:

Implement controls to prevent exposure to untreated sewage.

- Provide a barrier (e.g., plexiglass sheet) between the grinder and employee walkway.
- Modify the sample collection station to have the return active sludge fill closer to the base of collection container to reduce potential splash (e.g., add a hose to the spigot).
- Provide trash bags for the trash can in the Headworks Building 19 near the grinder to reduce exposures to untreated sewage and contaminated debris.

Recommendation 3: Install controls and improve work practices to reduce exposure to chemicals.

Why? Exposure to chemicals can cause a variety of health effects. Skin exposure from powdered lime can lead to or worsen symptoms of irritation or burning. Breathing powdered lime can lead to acute symptoms such as respiratory irritation. Chronic exposure can lead to lung disease.

How? At your workplace, we recommend these specific actions:

Replace the use of powdered lime with a liquid solution.

- Evaluate options to automate liquid treatment applications to further reduce employee exposures.

Encourage employees to change work clothes if their work clothing becomes soiled with powdered lime or untreated water.

- Consider providing dedicated work clothing (e.g., pants, shirts, boots, coveralls, etc.) for employees to change into at work and out of before leaving work.
- Remove soiled clothing to reduce skin exposure, prevent irritation, and prevent developing dermatitis.
- Launder soiled clothing separately before wearing again.
    - Clean contaminated work clothing daily with 0.05% chlorine solution (1 part household bleach to 100 parts water) (Reducing Health Risks to Workers Handling Human Waste or Sewage | Global Water, Sanitation, and Hygiene (WASH) | CDC).

Instruct employees voluntarily wearing NIOSH Approved® N95® filtering facepiece respirators on how to wear them properly.

- Provide voluntary N95 users a copy of Appendix D of the Occupational Safety and Health Administration (OSHA) Respiratory Protection Standard which provides information for employees about using respirators when not required under the standard.
- NIOSH publishes guides for employees on how to wear filtering facepiece respirators: How to Wear Your Filtering Facepiece Respirator (https://www.cdc.gov/niosh/npptl/pdfs/HowToWearYourFFR-508.pdf) and A Guide to Air-Purifying Respirators, DHHS (NIOSH) Publication No. 2018-176 (https://www.cdc.gov/niosh/docs/2018-176/pdfs/2018-176.pdf).

Increase personal protective equipment storage stations by task.

- Increase reusable personal protective equipment (e.g., gloves) to allow employees to change out soiled personal protective equipment more frequently.
- Provide additional storage locations specific for clean vs dirty personal protective equipment placement.

Recommendation 4: Reduce employee exposures that could lead to slips, trips, and falls.

Why? Slips, trips, and falls could cause injuries and days away from work. Employees were at risk from slips, trips, and falls from wet surfaces.

How? At your workplace, we recommend these specific actions:

Keep floors and steps as dry as possible.

- Provide barrier between grinder and employee walkway to prevent untreated sewage from splashing on the walkway.
- Maintain roof gutters to prevent pooling water near building entrances.
- Follow OSHA's general industry walking-working surfaces and fall protection standard (https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.21).

Control access to confined spaces.

- Modify the sludge hatch design to have a smaller opening point when removing sludge from the pit.
- Provide temporary barriers when hatches are open.
- Label the confined space in the Sludge Building 21.
- For additional information on step usage when entrance covers are removed, see OSHA regulation OSHA 1910.146(c)(5)(ii)(B) (https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.146).
- Information on identifying confined spaces is available in NIOSH's "A Guide to Safety in Confined Spaces" (https://stacks.cdc.gov/view/cdc/5830).

Recommendation 5: Address other health and safety issues we identified during our evaluation

Why? A workplace can have multiple health hazards that cause worker illness or injury. Similar to the ones identified above, these hazards can potentially cause serious health symptoms, lower morale and quality of life for your employees, and possibly increase costs to your business. We saw the following potential issues at your workplace:

- Confined spaces were not labeled. A floor hatch to the treated sludge pit created an entry to a confined space and risk of accidental entry fall.
- Pump rooms were loud, creating the potential for occupational noise exposures.

- Employees modified some work areas leading to potential workplace hazards.
- Hazard and policy communication methods left some employees confused.

Although they were not the focus of our evaluation, these hazards could cause harm to your workers' health and safety and should be addressed.

How? At your workplace, we recommend these specific actions:

Improve communication to address employee concerns in the workplace

- Update the written confined space policy and label all confined spaces.
    - Consider modifying the sludge pit hatch to better control access to the pit.
- Update process for employees to report hazards or concerns in the workplace.
- Provide employees with updated point of contact information for process documents.

Evaluate employees' noise exposures. Develop a hearing protection program as required.

- Evaluate noise levels in areas where pumps are running.
- Post signs to indicate when hearing protection is required.
- All employees that are included in the hearing loss prevention program should have a baseline audiogram and annual audiometric testing thereafter. The required elements for a hearing conservation program can be found in OSHA 1910.95(c) (https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.95).

Improve workplace setting to reduce employees modifying equipment

- Add a table or platform to help set the electric pump used to move the aluminum sulfate from the chemical tank to the clarifiers.

Supporting Technical Information

Evaluation of Indoor Environmental Quality at a State-Operated Wastewater Treatment Plant

HHE Report No. 2023–0044-3418

June 2025

Section A: Workplace Information

Employee Information

Number of employees: two

Length of shift: eight hours

Union: National Association of Government Employees

Process Description and Buildings

The wastewater treatment plant treats and processes municipal sewage from an adjacent facility. This plant was built between 1976 and 1978 with the last known renovation in 1993. The purpose is to create a clean effluent to release back into the environment by converting sewage solid waste to Class A and B biosolids. The EPA regulates biosolids treatment and reuse [EPA 2003]. Class A biosolids have been treated to eliminate detectable pathogens and Class B biosolids have been treated to reduce pathogens [EPA 1994]. This is a permitted Class B facility.

The treatment steps occur between the Headworks Building 19, Sludge Building 21, Filter Building 22, OPS Building 18, and outside locations. Employees spend 15–30 minutes on most tasks in the morning and again in the afternoon. Some processes that take longer were analyzing the samples and thickening treated sludge on the conveyor in Building 21.

Screening, Trash Removal, and Acidity Control

Screening and trash removal processes occur with the Headworks Building 19. The building is a single-story structure divided into two separate sections. The screening process area included a large grinder and storage for the powdered lime. Employees added the powdered lime to the wastewater to help control the acidity of the sludge. Initially employees would pour the powdered lime into this grinder (Figure A1). Due to mineral build-up on the grinder, the process was changed to have employees add the powdered lime into the outdoor aeration tanks.

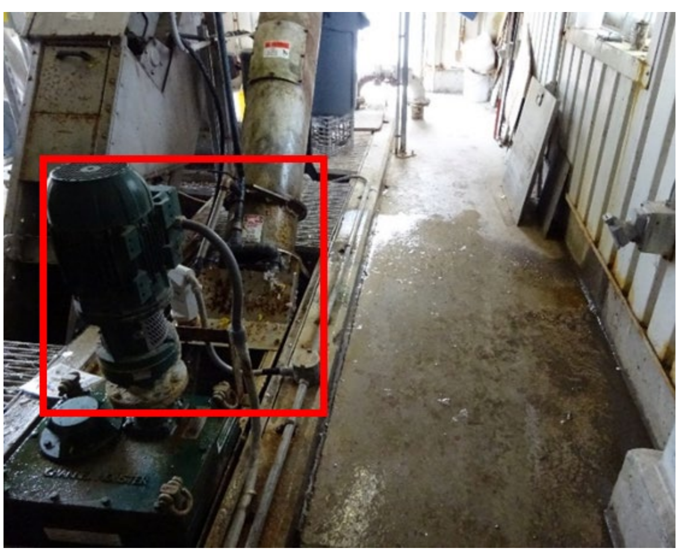

Figure A1. Original location where employees added powdered lime into the grinder located on the left. Photo by NIOSH.

Aeration and Settling

Employees monitor outside tanks used for aeration and settling. The waste moves outside into aeration tanks where employees add powdered lime. The plant has three aeration tanks and clarifiers but only two were operating during our visit. Clarifiers are used during the settling process. The chemicals added into the clarifier during the settlement process were stored in one 1500-gallon tank and another smaller tank that employees monitor in Headworks Building 19.

Filtration and Chlorination

After settling and aeration the water goes through the chlorine sand filtration in Filter Building 22. This building had two automated sand filters. The automated sand filter moves back and forth above the tank to shift the sand and water for filtration. Employees periodically check on the equipment and enter through one of the two side doors.

Final effluent (treated water) flows through channels and a de-chlorination process with sodium bisulfite added before water is returned to the plant water system or discharged to the river.

Sludge Treatment

Activated sludge and treatment processes happened in Sludge Building 21. The thickening of the sludge occurred on the first floor using a gravity belt. In addition, this building included a large grinder and storage room for forklift, lawn mowers, and chemicals. The basement had pumps to move the return active sludge and settling water from the clarifiers. The sludge water was returned back to the Headworks Building 19.

Quality Checks

Four samples taken from different stages of the treatment process were brought back to the Laboratory in OPS Building 18. This process helped to monitor that the treatment met EPA standards. The building had two levels: a ground level and basement. The ground level included a laboratory, office space, kitchen, bathroom with some lockers, and an electrical control room. In addition, this building included the process to add liquid chlorine into the sand filtration. The room holding liquid chlorine tanks was on the ground floor but separated from the main areas. Employees could only access the room from outside the building. The basement was split into two separate sections. One side provided access to the pumps and the other side access to a larger locker room with a washer and dryer unit to clean uniforms on-site.

Section B: Methods, Results, and Discussion

Methods: Observations of Work Processes, Procedures, and Conditions

During our site visit we:

- Observed work processes and workplace conditions.
- Visually inspected each buildings ventilation system(s).
- Observed personal protective equipment (PPE) use

Results: Observations of Work Processes, Procedures, and Conditions

Workplace Modifications

We observed areas where employees had modified the workstation to accommodate their work task. In the Headworks Building 19 employees modified the placement for an electric pump used to move aluminum sulfate into the clarifier tanks. Employees had used a wood plank to balance the lid to provide a smooth surface for an electric pump (Figure B1). In the same area we observed a space heater plugged into an extension cord. This was used to keep the room warm enough to maintain the temperature for the treatment process reaction (Figure B2). We observed another space heater the same size in the OPS Building 18 for the chlorination chemical room.

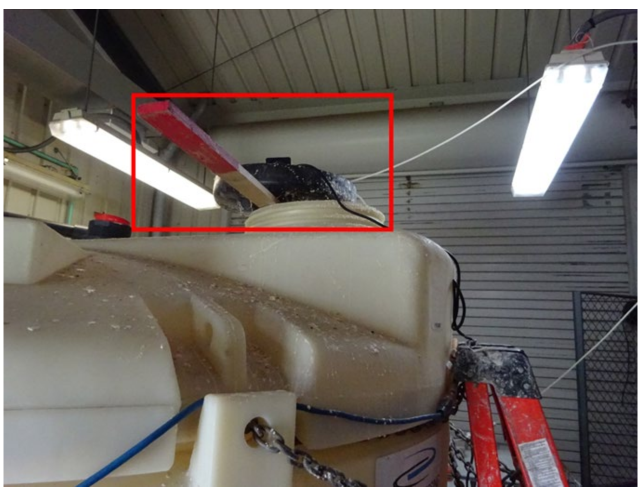

Figure B1. Electric pump for the sludge tank collection. Photo by NIOSH.

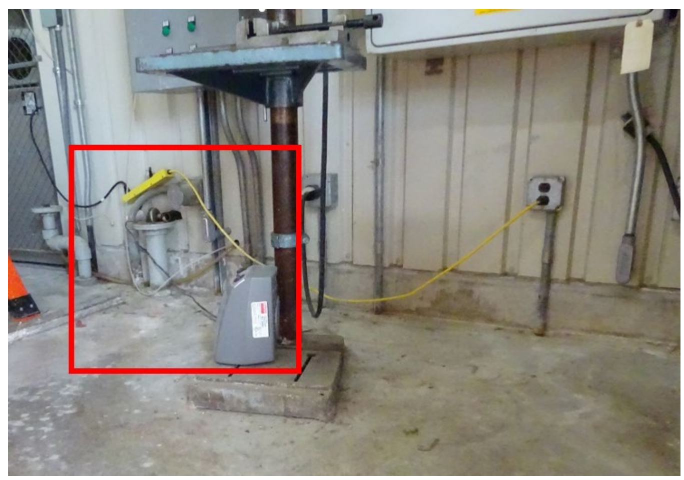

Figure B2. Portable space heater used to keep space warm in Headworks Building 19. Photo by NIOSH.

We observed some areas had spill catchment containers under stored portable chemical tanks. Employees modified the workplace to better empty containers before changing chemical tanks. In this case employees would place a piece of wood underneath the full sodium bisulfite tank to tilt it. This allowed for the equipment to pull out more of the chemical compared to when it sits flat on the floor.

We observed two areas where employees collected water quality samples near the end of the treatment process. The third sample area was automated by a machine. The employee had to manually lower a tube into the treated water before the machine starts. The cover was removable. We did not observe the sample collection process but saw the fourth sample location. This sample location was where the treated water enters the stream. This sample was to confirm the water entering the stream met EPA standards.

Powdered Lime Process

We observed that dust was generated when an employee manually added powdered lime to an aeration tank (Figure B3). The employee carried a 50-pound bag of powdered lime from storage in Building 19 to an aeration tank. At the time of our observations, the bag had partially ripped before the employee reached their destination spot to pour the powdered lime into the open tank. The employee's work clothes and walkway from storage were covered with some spilled powdered lime (Figure B4). Next, the employee placed the bag near the ramp and retrieved a shovel to help open the bag. The employee poured half of the bag into one tank and then carried the other half to another tank. Then, the employee used a bucket and shovel to help collect as much of the spilled powdered lime on the ground as possible. For the remaining powdered lime, the employee cleaned it by using a water hose to wash the area.

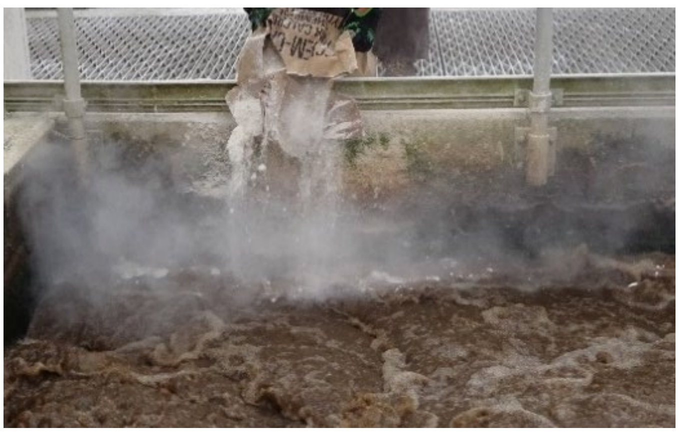

Figure B3. First area where employee adds powdered lime. Photo by NIOSH.

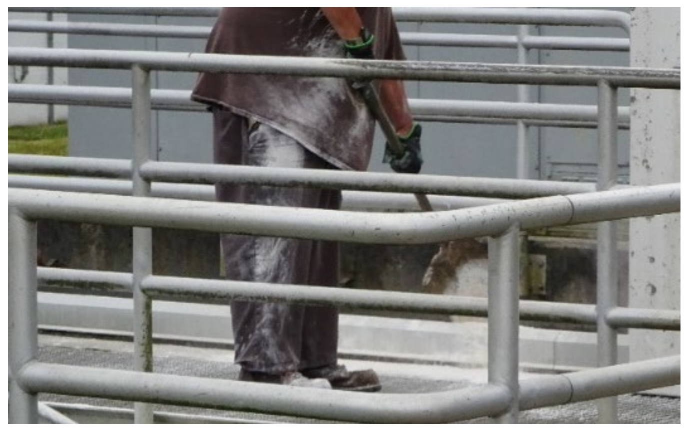

Figure B4. Employee using a shovel to clean the spilled powdered lime. Photo by NIOSH.

Untreated Sewage Exposure Risk

We observed the grinder splashing untreated water onto the employee walkway. The walkway was concrete with untreated water on the surface. We noticed employees walking through soiled area to access hand tools hanging on the rack near that area.

We observed contaminated debris from the screening process moved along a conveyor and dropped into a trash container. Figure B5 highlights in a red box that a trash container was propped on top of a box. Employees set the trash container on a box to reduce the distance for the debris dropped between the conveyor and into the container. Once the trash container was filled, employees moved it and poured the debris into the dumpster outside Headworks Building 19.

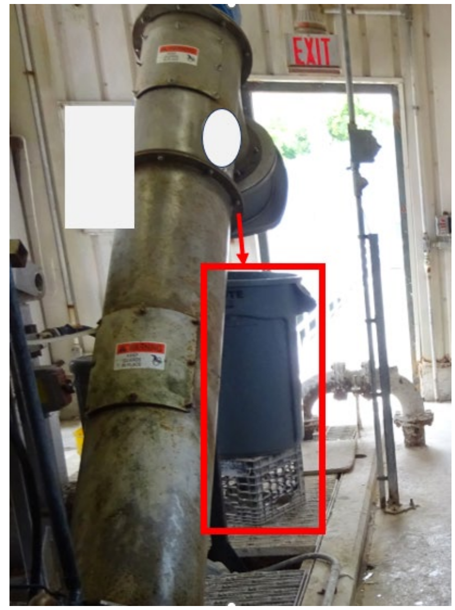

Figure B5. Trash can collection of debris removed from the grinder process. Photo by NIOSH.

We observed two areas in Building 21 where employees collected quality samples earlier in the treatment stage with potential back splash of waste. One collection area had an employee drain content from the return activated sludge (RAS) pumps into a bucket to collect a liquid sample. Figure B6 shows that in front of the RAS pipeline highlighted in a red box are another pipe and open bucket. The bucket was in place to collect a sample. A red arrow is pointed down to highlight the soiled floor with RAS. The second collection area had an employee use a container and hold it near the conveyor to collect the solid waste sample. Figure B7 shows in a red box the area where an employee will collect the solid sludge for a quality sample from the conveyor.

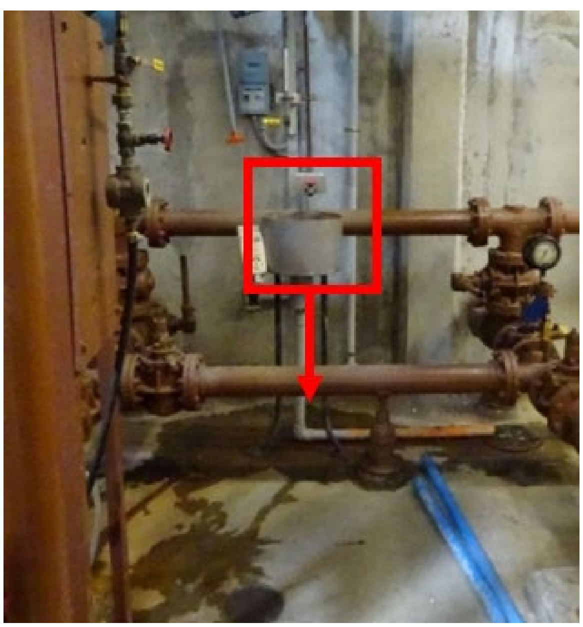

Figure B6. Return activated sludge for sample collection. Photo by NIOSH.

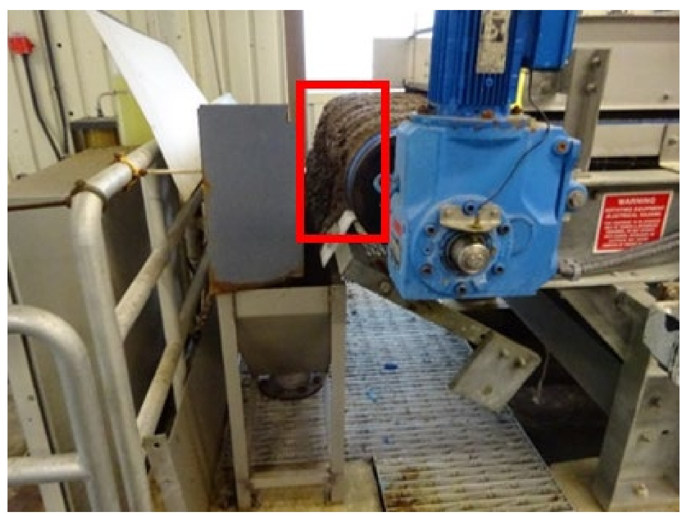

Figure B7. Solid sludge on conveyor belt to collect sample. Photo by NIOSH.

Ventilation

We observed four different HVAC systems between Buildings 18, 19, 21, and 22. Management had installed a new mini-split system in May 2024, for the laboratory in OPS Building 18. This system could control temperature and humidity, but could not provide outdoor air to, or exhaust air from the laboratory. Employees spend 2-3 hours per day in the laboratory of OPS Building 18 compared to the other three buildings. Management had a belt replaced for the ventilation system on the first floor of Sludge Building 21. We observed a light hung in front of a return vent in Building 21 with potential to interfere with air flow (Figure B8). Management could not repair the ventilation system in Building 22 due to limited access to the ventilation system above the automated sand filters (Figure B9). The ventilation is located over the automated sand filtering banks. We observed two areas where employees used a space heater to maintain heat in Headworks Building 19 and OPS Building 18.

Figure B8. Sludge Building 21 ventilation return near conveyor. Photo by NIOSH.

Figure B9. Filter Building 22 ventilation unit over the automated sand filtering banks. Photo by NIOSH.

Confined Spaces

Employees received OSHA's training about awareness of confined spaces. Management informed us they are updating their documentation and procedures regarding the confined space protocol for this plant and other locations. Employees at this location were trained to not enter any confined spaces.

We observed one location in Building 22 that created a confined space when that hatch was open for collection. We were informed employees open the hatch once a week for a contractor to collect the sewage (Figure B10). The process required an employee to open the hatch and the contractor place a hose into the pit. Due to its size, this opening could be a potential confined space hazard. The pit is more than ten feet deep and there is no ladder inside. We noticed no signs posted to indicate areas for confined space.

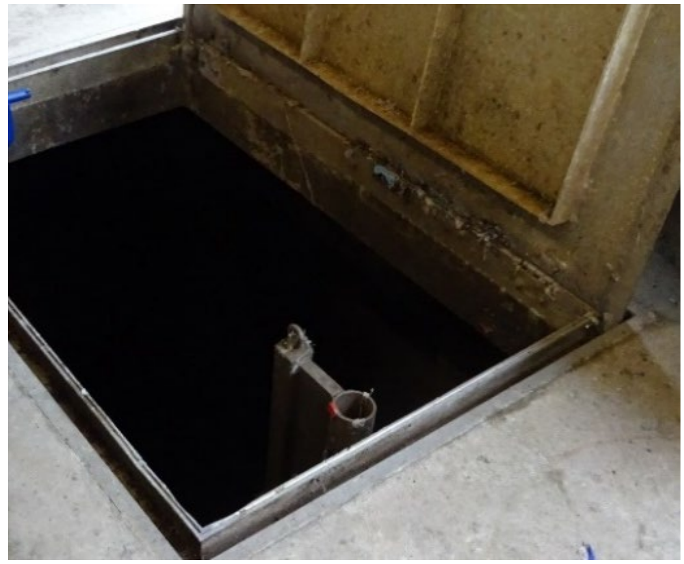

Figure B10. Open hatch for weekly waste collection. Photo by NIOSH.

NIOSH defines a confined space as a space that by design has limited openings for entry and exit, unfavorable natural ventilation that could contain or produce dangerous air contaminants, and that is not intended for continuous employee occupancy [NIOSH 1979a, 2011]. We observed areas that met the definition of confined spaces based on the NIOSH guidelines. One location was an entry point that lowers into the chlorine filtered water which is released into the stream.

Noise

In the sludge treatment basement, we noticed a high-pitched noise in the area near the plant water pumps. This plant runs two pumps per line.

In the OPS Building 18 basement, we noticed loud noise generated by the two running pumps (Figure B11). The larger pumps were not running as the facility was operating at half capacity.

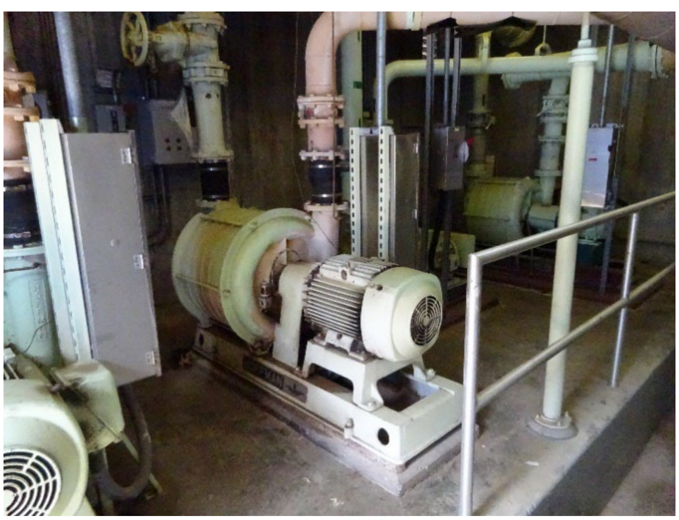

Figure B11. OPS Building 18 basement pumps used for aeration tanks. Photo by NIOSH.

Personal Protective Equipment

We observed different locations where employees access and store their PPE. We did observe employees use the same pair of reusable gloves for multiple tasks. The gloves were permeable fabric with a rubbery pattern applied to improve grip. During our visit employees had access to a washer and dryer located in OPS Building 18 basement locker room to clean their uniforms and reusable gloves.

- The observed employee wore safety googles, a filtering facepiece respirator, and reusable gloves when moving and pouring the powered lime. Employees stored their respirators in the Headworks Building 19 storage cabinet near the enclosed chemical tanks.
- The observed employee wore a face shield, reusable gloves and apron when collecting samples from the conveyor. Employees stored their PPE in Sludge Building 21 located across from the conveyor.
- The observed employee had access to disposable powder-free nitrile gloves in OPS Building 18 laboratory area when preparing sample analysis.

Methods: Direct Reading Instrument Observations

We used a TSI® Q-Trak to measure levels of hydrogen sulfide (H_2S), volatile organic compounds (VOC), carbon monoxide (CO), carbon dioxide (CO_2), temperature (°F), and percent relative humidity (% RH) in the workplace. We made spot measurements throughout the workplace (inside and outside every building) over a full work shift. Additionally, we used six HOBO® Pro V2 series data loggers to measure °F and RH. We logged data for 24 hours to understand the ventilation inside.

Results: Direct Reading Instrument Observations

Chemical Gases

Outside measurements were as follows: H_2S ranged from 0.45–0.62 parts per million (ppm) with an average of 0.58 ppm. VOCs ranged from 0–1.2 ppm with an average of 1.14 ppm. CO ranged from 0–0.1 ppm with an average of 0.01 ppm. CO_2 ranged from 393–487 ppm with an average of 417 ppm.

Measurements inside OPS Building 18 were as follows: H_2S ranged from 0.15–0.56 ppm with an average of 0.56 ppm. VOCs were 1.3 ppm for all inside measurements. CO was not detected. CO_2 ranged 927–1,198 ppm with an average of 990 ppm.

All measurements we made for gases were well below the most restrictive occupational exposure levels (OELs) reference section C.

Temperature and Relative Humidity

Outside temperatures ranged from 82.1°F–101°F with an average of 93.5°F. % RH ranged from 35%–100% with an average of 81.4% RH.

OPS Building 18 temperatures ranged from 67.1°F–80.8°F with an average of 72.6°F. % RH ranged from 43.4%–71% with an average of 58.6% RH.

Discussion

Ventilation

The deteriorated HVAC system in the Filter Building was a persistent issue. Due to the way it was installed, it cannot be serviced in place. Management had been working with a contractor to engineer a solution but budget issues prevented further progress.

The newly installed mini-split system in OPS Building 18 controlled temperature and relative humidity but could not provide outdoor air to, or exhaust air from the laboratory. Employees reported being satisfied with the improvements the unit made in the laboratory.

Wastewater treatment plants do not have a specific ventilation standard, but the laboratory in OPS Building 18 can apply the ANSI/ASHRAE Standard 62.1-2022: Ventilation for Acceptable Indoor Air Quality guidelines. This guideline provides specific details on ventilation for acceptable indoor environmental quality. A ventilation system expert can help meet ASHRAE ventilation guidelines in the building.

ANSI/ASHRAE Standard 55-2023, Thermal Environmental Conditions for Human Occupancy, specifies conditions in which 80% or more of the occupants would be expected to find the environment thermally acceptable [ANSI/ASHRAE 2023]. Assuming slow air movement and 50% RH, the operative temperatures recommended by ANSI/ASHRAE range from 68.5°F to 76°F in the winter and from 75°F to 80.5°F in the summer. The difference between the two is largely due to seasonal clothing selection. Our measurements show that the mini-split maintained steady temperature levels within the recommended range.

ASHRAE Standard 62.1-2022, Ventilation for Acceptable Indoor Air Quality, requires that RH levels be designed to be limited to 65% or less for mechanical systems with dehumidification capability [ANSI/ASHRAE 2022]. For other mechanical system types or where spaces are not served by mechanical systems, Standard 62.1 has no humidity limitations. Excessive humidity can promote the growth of mold, and microorganisms (e.g., dust mites). The standard does not specify a lower humidity limit but notes that nonthermal comfort factors such as skin drying, irritation of mucus membranes, dry eyes, and static electricity may place limits on acceptability of very low humidity environments. Our measurements show that the mini-split maintained steady humidity levels within the recommended range.

Bacteria and Other Pathogens

There are four major types of human pathogenic organisms found in sewage sludge: (1) bacteria, (2) viruses, (3) protozoa, and (4) helminths (parasitic worms) [Boczek et al. 2023; LeChevallier et al. 2020]. The levels of pathogens present in the sewage sludge depend upon the number of microorganisms present in the waste stream and the reduction of pathogenic organisms achieved by the wastewater and sewage treatment processes. Some of these pathogens can cause gastrointestinal illnesses, and others can cause skin infections in individuals with cuts and/or abrasions. Some are present infrequently, depending, in part, on geographic area and what is occurring in the community that the wastewater treatment plant serves. The employees who work at this facility have potential exposures to untreated wastewater. Specific locations included the grinder in the Headworks Building 19 and the collection bowl in Sludge Building 21. Routine job tasks such as sample collection, maintenance, and housekeeping present splash exposures to untreated and partially treated wastewater. In addition, wet walking surfaces in the workplace can increase the risk of injury from a slip.

Powdered Lime

We observed powdered lime spilling on an employee's personal protective equipment and clothing while performing a job task. Manufacturers provide a safety data sheet which lists proper handling procedures, including the recommended PPE for safe use.

OSHA and NIOSH Definition for Confined Spaces

OSHA's confined space regulations can be found at 29 CFR 1910.146 [OSHA 2024]. OSHA defines a confined space as a space large enough to physically enter, that has limited entry and exit and is not designed for continuous human occupancy. OSHA classifies confined spaces as permit required when one or more of the following conditions are met: (1) the space contains or has the potential to contain a hazardous atmosphere, (2) the space contains material that could engulf someone in the space, (3) internal configuration is such that the entrant could be trapped or asphyxiated, and (4) the space contains any other recognized serious safety or health hazard.

NIOSH defines a confined space as a space that by design has limited openings for entry and exit, unfavorable natural ventilation that could contain or produce dangerous air contaminants, and that is not intended for continuous employee occupancy [NIOSH 1979a, 2011]. In the NIOSH confined space criteria document, confined spaces are classified on the hazard potential or existing hazard.

Confined spaces are divided into three classes: class A (Immediately Dangerous to Life or Health IDLH), class B (dangerous but not IDLH), and class C (a potential hazard). All three classes require atmospheric testing [NIOSH 1979a]. Continuous monitoring of the confined space is required for class A and optional for class B and C. Unlike OSHA, NIOSH recommends an entry permit system and the use of rescue procedures for all three confined space classifications. Classes A and B require a standby person equipped with a self-contained breathing apparatus. For class C spaces, rescue personnel must use supplied air or self-contained breathing apparatus to remove victims. NIOSH recommends training at least annually for any confined space entry [NIOSH 1979a].

Because these spaces (e.g.: manhole at headwater, sludge pit hatch access, etc.) were not designed for continuous occupancy and had limited means of entry and egress, they were considered by the employer as permit-required confined spaces per 29 Code of Federal Regulations (CFR) 1910.146 [OSHA 2024]. These spaces also meet the NIOSH criteria for a confined space requiring an entry permitting procedure to ensure safe employee entry, work, exit, and rescue [NIOSH 1979a]. In addition, the manhole created the possibility for an employee to fall into the sludge pit.

PPE

Employees reused gloves for different maintenance and general tasks throughout the facility. Without clear guidance on reusable PPE use, cleaning, and storage, they may unintentionally expose themselves and each other to untreated water and process chemicals. Reusable PPE (e.g., permeable fabric gloves) should be decontaminated when soiled. One-time use PPE (e.g., nitrile gloves) need to be disposed properly to prevent contamination [Reducing Health Risks to Workers Handling Human Waste or Sewage | Global Water, Sanitation, and Hygiene (WASH) | CDC].

Limitations

This evaluation was subject to limitations. Exposure assessment could only document exposures and conditions in the locations evaluated and on the day this evaluation occurred. These results may not represent conditions during seasonal changes (e.g., extreme cold or hot temperatures). The plant was treating wastewater at 50% capacity. We did not observe the process change to use liquid sodium hydroxide instead of hydrated lime that was installed in August 2024, after our site visit.

Conclusions

Employees were exposed to untreated and partially treated wastewater. These exposures lead to increased risk of infection from waterborne pathogens. Employees were at risk for exposure to powdered lime. All measurements we made for gases were well below the most restrictive OELs. The newly installed HVAC system in OPS Building 18 could control temperature and humidity, but could not provide outdoor air to, or exhaust air from the laboratory.

Attribution Statement

N95 and NIOSH Approved are certification marks of the U.S. Department of Health and Human Services (HHS) registered in the United States and several international jurisdictions.

Section C: 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 preexisting 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 short-term exposure limits (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.

- OSHA, an agency of the U.S. Department of Labor, publishes permissible exposure limits [29 CFR 1910 for general industry; 29 CFR 1926 for construction industry; and 29 CFR 1917 for maritime industry] called PELs. These legal limits are enforceable in workplaces covered under the Occupational Safety and Health Act of 1970.

- NIOSH recommended exposure limits (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 2007]. NIOSH also recommends risk management practices (e.g., engineering controls, safe work practices, employee education/training, PPE, and exposure and medical monitoring) to minimize the risk of exposure and adverse health effects.

- Another set of OELs commonly used and cited in the United States includes the threshold limit values or TLVs, which are recommended by the American Conference of Governmental Industrial Hygienists (ACGIH). The ACGIH TLVs are developed by committee members of this professional organization from a review of the published, peer-reviewed literature. TLVs are not consensus standards. They 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 2025].

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 https://www.dguv.de/ifa/gestis/gestis-stoffdatenbank/index-2.jsp, contains international limits for more than 2,000 hazardous substances and is updated periodically.

OSHA (Public Law 91-596) 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. 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.

Hydrogen Sulfide

Acute airborne exposures to hydrogen sulfide above 10 ppm have been associated with eye disorders, including conjunctivitis and keratitis [NIOSH 1977a]. Conclusive evidence of adverse health effects from chronic exposure at concentrations below 20 ppm is lacking [29 CFR 1910.1000; Beauchamp et al. 1984; Glass 1990; HSDB 2014; NIOSH 1992; Schechter et al. 1989]. IARC does not have a designation of its carcinogenicity [IARC 1999; 2012]. OSHA has established a ceiling limit of 20 ppm, and a 10-minute maximum peak of 10 ppm [OSHA 2006]. NIOSH has established a 10-minute ceiling of 10 ppm [NIOSH 2007]. ACGIH has established a TLV of 1 ppm as an 8-hour TWA and a STEL of 5 ppm [ACGIH 2025].

Carbon Monoxide

CO is a colorless, odorless, tasteless gas produced by incomplete burning of carbon-containing materials, e.g., gasoline. The initial symptoms of CO poisoning may include headache, dizziness, drowsiness, and nausea. These initial symptoms may advance to vomiting, loss of consciousness, and collapse if prolonged or high exposures are encountered. Coma or death may occur if high exposures continue. Exposure to CO limits the ability of the blood to carry oxygen to the tissues by binding with the hemoglobin to form carboxyhemoglobin (COHb) [ACGIH 2025; NIOSH 1972, 1977b, 1979b, 2007; Proctor et al. 1988]. The NIOSH REL for CO is 35 ppm for an 8-hour TWA exposure, with a ceiling limit of 200 ppm that should not be exceeded [NIOSH 2007]. The NIOSH REL is designed to protect workers from health effects associated with COHb levels in excess of 5% [NIOSH 1972]. The ACGIH recommends a TLV of 25 ppm as an 8-hour TWA. This is designed to protect workers from health effects associated with COHb levels in excess of 3.5% [ACGIH 2025]. The OSHA PEL for CO is 50 ppm for an 8-hour TWA exposure [29 CFR 1910.1000].

Noise

Noise-induced hearing loss (NIHL) is an irreversible condition that progresses with noise exposure. NIHL is caused by damage to the nerve cells of the inner ear and, unlike some other types of hearing disorders, cannot be treated medically [AIHA 2022]. Approximately 25% of U.S. workers have been exposed to hazardous noise [Kerns et al. 2018] and more than 22 million U.S. workers are estimated to be exposed to workplace noise levels above 85 dBA [Tak et al. 2009].

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 [Rosler 1994]. NIHL can result from short duration exposures to high noise levels or even from a single exposure to an impulsive noise or a continuous noise, depending on the intensity of the noise and the individual's susceptibility to NIHL [AIHA 2022].

Noise measurements are usually reported as 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 kHz" and is considered to provide a better estimation of hearing loss risk than D-4 using unweighted or other weighting measurements [Murphy et al. 2022]. The dB unit is dimensionless, and it represents the logarithmic ratio of the measured sound pressure level to an arbitrary reference sound pressure of 20 micropascals, which is defined as the threshold of normal human hearing at a frequency of 1 kHz. Because the dB is logarithmic, an increase of 3 dB is a doubling of the sound energy, an increase of 10 dB is a 10-fold increase, and an increase of 20 dB is a 100-fold increase in sound energy.

Workers exposed to noise should have baseline and yearly hearing tests (audiograms) 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 frequencies of 0.5 kHz, 1 kHz, 2 kHz, 3 kHz, 4 kHz, and 6 kHz. NIOSH also recommends testing be done at 8 kHz [NIOSH 1998].

The OSHA hearing conservation standard requires analysis of hearing changes from baseline hearing thresholds to determine if a standard threshold shift (STS) has occurred. OSHA defines an STS as a change in hearing threshold relative to the baseline hearing test of an average of 10 dB or more at 2 kHz, 3 kHz, and 4 kHz in either ear [29 CFR 1910.95]). If an STS 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 an increase in the hearing threshold level of 15 dB or more, relative to the baseline audiogram, 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 this 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. When noise exposures exceed the REL, NIOSH recommends the using hearing protection and implementing a hearing loss prevention program [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. OSHA requires implementation of a hearing conservation program when noise exposures exceed the AL [29 CFR 1910.95].

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