

WORKPLACE SOLUTIONS

From the National Institute for Occupational Safety and Health

Reducing Hearing Loss in Recycling Workers

Summary

Recycling facilities include workplaces that receive automotive scrap, industrial scrap, electronic waste (e-waste), or other recyclable materials to process and resell [ISRI 2023]. Workers in these facilities are at risk of hearing loss due to noise exposure from machines such as industrial shredders and balers. They may also be exposed to hazardous chemicals that can damage their hearing (referred to as ototoxicants). The National Institute for Occupational Safety and Health (NIOSH) provides information (based on NIOSH practices for protecting workers from chemicals and noise exposures) to reduce hazardous noise and chemical exposures for workers in recycling.

Types of Recycling

Nearly 160,000 workers (not including incarcerated populations) are directly involved in recycling e-waste, scrap, and other waste [EPA 2020; ISRI 2023]. Recycling jobs make up 0.5% of the U.S. economy [EPA 2020]. Workers in recycling facilities perform tasks such as receiving, sorting, shredding, baling,

disassembly, refurbishing, transporting, and shipping. Materials that are recycled include the following:

Electronic Waste (E-waste)

E-waste consists of items that contain electronic components, including smartphones and small appliances [DTSC 2024]. E-waste can be recycled through repair, refurbishment, shredding, or by dismantling into separate components.

Scrap

Scrap metal recycling is the processing of “end of life” products into commodity-grade raw materials to make new goods [Cohen USA 2023].

Other Recyclable Materials

Other materials processed in recycling facilities include paper, cardboard, metal, glass, tires, textiles, rubber, and plastic.

Settings for Recycling

The processing of recyclable materials often occurs at indoor licensed facilities

where some worker safety and health as well as environmental controls are in place for these fixed sites (see Figure 1) [Ceballos and Dong 2016]. However, recycling may also be processed in shredding trucks or at correctional facilities [Carlson et al. 2021; UNITAR 2024].



Figure 1. Image from a NIOSH health hazard evaluation (HHEs) at a fixed recycling site in the United States

Mobile Shredding Trucks

Mobile shredding trucks have recently been introduced to manage e-waste and other recyclable materials. While convenient, these trucks can produce hazardous levels of noise and present unique safety and health risks for workers because of the confined space (especially for workers in the back of the truck) and exposure to metals, particulate dusts, and temperature extremes [Ceballos et al. 2020a]. More research on mobile shredding trucks is needed



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to understand the hazards associated with this waste processing approach.

Correctional Facilities

Electronic and other waste recycling work may be performed by incarcerated workers [ACLU/GHRC 2022]. This work may occur within an on-site recycling center operated by a correctional facility, or at a municipal recycling facility where incarcerated persons perform work in the community while serving a sentence of confinement. With in-house recycling operations in county jails, state prisons, or federal facilities, incarcerated persons perform work for wages. For example, Bureau of Prisons (federal) incarcerated persons who receive a wage for tasks performed are considered “workers” and the applicable safety and health protections apply, including the right to file a report of hazards with appropriate health and safety professionals [OSHA 1995].

Hazards to Hearing Health

Risks to hearing health can occur in any occupational setting. However, some factors such as informal employment, incarceration, immigration status, and temporary worker status can all contribute to higher rates of illness and injury (including hearing loss) among some workers [Flynn et al. 2022; Ceballos et al. 2020b; Ceballos and Dong 2016].

Noise

High levels of noise can eventually lead to severe hearing difficulties. Overexposure to noise can also cause tinnitus (ringing in the ear) and hyperacusis (abnormal sensitivity to sound) [NIOSH 2019d; 2024e]. Noise is considered hazardous or loud when it reaches 85 decibels or higher.

Repeated exposure to impulsive noise* can result in permanent noise-induced hearing loss [Chan et al. 2001]. Impulsive noise can permanently damage unprotected ears in minutes (rather than the days or years typical of continuous industrial noise exposures) [NIOSH 2019a]. During the recycling process, especially disassembly and shredding, loud noise is generated by the machinery and the processing of material in the shredder. Balers have multiple sources of noise: they use both pneumatic and electrical energy. Loud noise is also emitted by the release of compressed air from the baler ram and the process of the baler compressing materials. Recyclable materials, such as glass, can emit noise as they move through the process and through machinery. When scrap metal is recycled, workers are exposed to high levels of noise during torch cutting, baling, and compacting.

*Impulsive noise is typically generated by the rapid release of compressed gases (impulse) or the collision of solid objects (impact) and is defined as the instantaneous change in sound pressure over a short period of time [NIOSH 2018d].

Noise levels taken at one recycling site during a NIOSH health hazard evaluation (HHE) ranged from 84 to 98 dB (at or above the level that NIOSH considers to be hazardous to hearing health) while workers used a granulator in the dismantling building [NIOSH 2019b]. Sound levels peaked at 123 decibels at another recycling company “when scrap metal was dumped into a metal container” [p.30 NIOSH 2019a].

Chemicals

In addition to noise from machinery and processes, the process of recycling e-waste and scrap metal can release toxic materials [ILO 2012]. Some of these substances may be ototoxicants, meaning that they can cause hearing loss, regardless of noise levels [OSHA/NIOSH 2018].

Potential ototoxicants, such as lead, and cadmium [OSHA/NIOSH 2018; Choi et al. 2012] were found during NIOSH health hazard evaluations at two e-waste recycling centers in the United States [NIOSH2019a,b]. NIOSH also found lead and cadmium exposures during hazard evaluations conducted at other recycling facilities [NIOSH 2009, 2014, 2018a,b].

Occupational Exposure Limits

At the federal level, NIOSH establishes recommended exposure limits (RELs) for hazardous substances and noise on the basis of the best available scientific evidence.

Noise

The NIOSH REL for noise is 85 decibels, using the A-weighted frequency response (often written as dB(A) or dBA) averaged over an 8-hour workday—usually referred to as the time-weighted average (TWA) [NIOSH 1998]. The A-weighting of noise levels is used to provide a rating that indicates the harmful effects of noise on human hearing. Exposures at or above the REL are considered hazardous to hearing health [NIOSH 1998]. NIOSH also recommends that peak sound pressure level not exceed 140 dBA [NIOSH 1998].

For noise exposure, the OSHA regulatory limit, or the permissible exposure limit (PEL), is 90 dBA, and the action level is 85 dBA, both as 8-hour TWAs [29 CFR[†] 1910.95]. The OSHA occupational noise standard states that exposures to impulsive noise should not exceed 140 dB peak sound pressure level [29 CFR 1910.95].

Chemicals

NIOSH RELs and OSHA PELs have been established for some (but not all) of the chemicals found in e-waste and other recyclables (such as lead and cadmium). NIOSH RELs and OSHA PELs for chemical hazards are listed in the NIOSH Pocket Guide. OSHA PELs are also listed on the OSHA website.

[†]Code of Federal Regulations. See CFR in References.

Other Health Effects

Noise

In addition to hearing loss, noise has been associated with increased injury risk and absenteeism and can sometimes lead to decreases in performance (especially for complex or simultaneous tasks) [NIOSH 2011, 2019; Carlson et al. 2021; Themann et al. 2013; Ceballos et al. 2020a; Shkempi et al. 2022]. Noise has been associated with stress and hypertension [NIOSH 1998]. Symptoms such as headaches, irritability, increased tension, fatigue, and sleep disorders have also been described [NIOSH 2011]. Noise has also been associated with cardiovascular conditions [Kerns et al. 2018; Li et al. 2019]. Implementing strategies that minimize noise exposure to workers has positive health effects beyond hearing health [NIOSH 2019d].

Chemicals and Noise

Hearing loss can be even greater with exposure to both ototoxic chemicals and noise than exposure to either noise or the ototoxic chemical alone [Johnson and Morata 2010]. Some ototoxic chemicals, such as certain solvents, might exacerbate noise-induced hearing loss even when the noise exposure is below OSHA's PEL or NIOSH's REL. No exposure limits are specified for the combination exposures of noise and chemicals [OSHA/NIOSH 2018; EU-OSHA 2009; Morata et al. 1997].

Controls

Reducing the risk of adverse effects from both noise and chemical exposures can be considered in terms of the **hierarchy of controls**, which designates the order of effectiveness of the controls (see Figure 2). When applying controls, eliminating the exposure or substituting a less hazardous material are the most effective ways of protecting employees, though these controls are not usually possible in processing recyclable materials. Next in the hierarchy is engineering controls, such as ventilation or noise-reducing enclosures. Next are administrative procedures, such as work practices and adjusting schedules to reduce the duration of exposure. Lowest in the hierarchy is the use of personal protective equipment (PPE) (wearing protective clothing or hearing protection) [NIOSH 1996, 2024a]

The following steps can help reduce the risk of occupational hearing loss in recycling workers [NIOSH 1980, 1987, 1996, 1998, 2024a,b,c,d,e,f; OSHA/NIOSH 2018].

What Employers Can Do

Develop a site-specific safety and health plan. This plan can include an initial assessment of all workplace hazards,

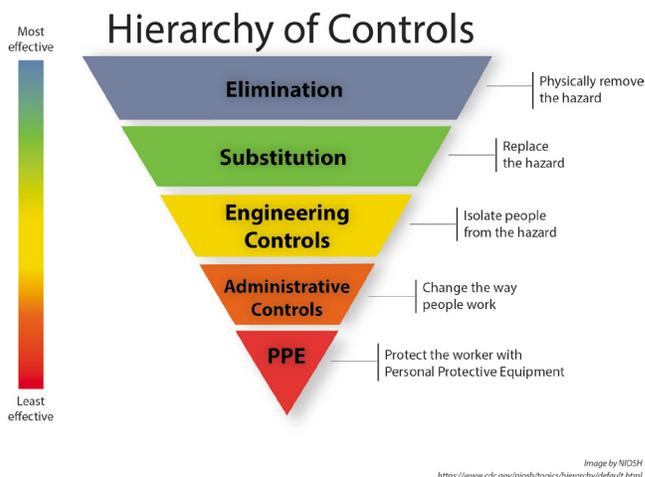


Figure 2. Hierarchy of Controls (Note: PPE stands for personal protective equipment).

including the potential noise and chemical exposures in the workplace. This initial assessment can aid employers in issuing guidance on recognizing when toxic chemicals may be released or generated. Employers can also construct a noise map of their workplace to identify areas where hazardous noise is present and post signage reminding employees to wear their hearing protection in noisy areas. [OSHA 2022]. The employer may consider identifying strategies to control or eliminate exposures to noise and chemicals that include engineering controls, work practices such as frequent hand-washing, and personal protective equipment [NIOSH 1996, 2018c; CDC 2022].

When any worker's 8-hr TWA exposure equals or exceeds 85 dBA, an employer should conduct a noise exposure assessment that conforms to the American National Standard Measurement of Occupational Noise Exposure, ANSI S12.19-1996 [ANSI 1996].

Controls for ototoxicants may depend on the specific chemical. As a general measure, employers can ensure that work areas are well ventilated. In accordance with the OSHA Hazard Communication standard, 1910.1200 – safety data sheets (SDS) should be made available for all chemicals known to be present in the workplace. SDS can also be displayed in other languages. Consider doing an inventory of materials received and acquire SDSs for appropriate chemicals. The OSHA-NIOSH Safety and Health Informational Bulletin, NIOSH Pocket Guide, International Chemical Safety Cards, and Toxicological Profiles from the Agency for Toxic Substances and Disease Registry are also sources of information about chemicals. NIOSH has information about controlling exposure to **lead** and **cadmium**.

Substitution

- Since eliminating noise may not be feasible in a setting where metals, electronics, and other materials are recycled, consider a **Buy Quiet** program to buy quieter machinery and tools to reduce noise levels and set design specifications for noise levels when purchasing equipment. Check whether noise levels of equipment are specified by the manufacturer [NIOSH 1996, 2016, 2024b].
- Consider safer products when comparing products for use within the facility. Water-based degreasers (for machine maintenance) and cleaners are generally safer (than solvent or oil-based degreasers) for both the user and the environment [NIOSH 1987, OSHA/NIOSH 2018]. The United States Environmental Protection Agency [EPA 2024] has a **database of safer chemical alternatives**.

Engineering controls

- Apply appropriate **noise control measures**, such as sound transmission barriers or walls, and absorptive materials [NIOSH 1980, 1998]. For outdoor operations, a mix of natural vegetative (e.g., plants, trees, grass) buffers (earthen berms) can also limit noise [NIOSH 2012, 2024b,e].
- Isolate machinery, such as shredders, from other work areas to reduce employee noise exposure [NIOSH 1980, 1998, 2024b,c,f]. Augmenting isolation areas with good ventilation and negative static pressure helps prevent migration of ototoxic air contaminants into nearby work areas [NIOSH 1987, OSHA/NIOSH 2018].
- Enclose machinery that produces high noise levels, such as grinders, shredders, and balers [NIOSH 1980, 1998]. Maintain the enclosures with negative pressure ventilation if ototoxic chemicals may be present [NIOSH 1987, 2024c].
- Keep noisy machinery away from sound-reflective surfaces (hard surfaces such as walls, floors, and ceilings), and use sound dampening materials to limit the reflection of sound [NIOSH 1980].
- Secure or insulate any vibrating parts of machinery; vibration can be a source of noise [NIOSH 1980, 1998, 2024c].
- Ensure that all equipment is well maintained [OSHA 2022].

Administrative controls

- Allow workers to take breaks (from noise and chemicals) in quiet, clean areas [NIOSH 1998, 2024f].
- Provide training for workers on noise and chemical exposures, health effects, and risks of hearing loss (among

other topics) [NIOSH 1996, 1998]. *See **Preventing Occupational Noise-Induced Hearing Loss | NIOSH | CDC**

PPE

- **Provide hearing protection** where noise levels are at or above 85 dB [NIOSH 1998, 2024f].
- Provide double hearing protection (i.e., both earplugs and earmuffs) where noise levels are at or above 100 decibels [NIOSH 1998, 2018e].
- Provide hearing-protector fit testing for individual hearing protection devices for workers [NIOSH 1998, 2013].
- When airborne ototoxic chemicals may be present, select and provide appropriate respiratory protection and ensure workers are enrolled in an OSHA-compliant respiratory protection program (that includes fit testing) [OSHA 1910.134; NIOSH 1987, OSHA/NIOSH 2018].

What Workers Can Do

- Ask your employer about a workplace hearing conservation program if one is not already in place [NIOSH 1998].
- Have your hearing tested annually as part of the employer's hearing conservation program [NIOSH 1998].
- Try to take a break from the noisy activity or reduce your time in noisy areas [NIOSH 1998, 2024g]. (If you must raise your voice to speak to someone an arm's length away then noise levels are likely hazardous).
- When exposure to ototoxicants is anticipated, complete respiratory protection training and wear appropriate respiratory protection whenever such exposure potential exists [OSHA 1910.134; NIOSH 2018e].
- Complete the training provided by your employer on noise exposure and hazards to hearing health [NIOSH 1998].
- Many ototoxic substances can be absorbed through the skin. Wear the appropriate chemical-protective gloves, arm guards, aprons, and other protective clothing to reduce dermal exposure [NIOSH 1987, OSHA/NIOSH 2018].
- Wash your hands before eating or smoking [NIOSH 2024d].
- Use hearing protection
 - **Always** wear hearing protection in noisy areas [NIOSH 1998, 2024g].

[†]Training should also include the following [NIOSH 1998]:

1. Physical and psychological effects of noise
2. Hearing protection selection, fitting, use and care
3. Audiometric testing
4. Roles and responsibilities of both employers and workers in preventing noise-induced hearing loss.

- Wear your hearing protection correctly (also off the job when you are exposed to noise). Follow manufacturer instructions for proper use. [NIOSH 1998, 2019d, 2024e,g].
- Wear earmuffs over earplugs in areas where noise levels are at or above 100 dBA [NIOSH 1998, 2018e].

Information for Workers

- Download these apps
 - NIOSH **sound level meter** app its measurement capabilities are similar to those of professional noise measurement tools [NIOSH 2024g].
 - Check your hearing with the **hearwho** app to see whether a professional audiometric evaluation might be needed [WHO 2024].
- Check if a chemical can cause hearing damage [NIOSH/OSHA 2018]: **Preventing hearing loss caused by chemical (ototoxicity) and noise exposure.**

Suggested Citation

NIOSH [2024]. Reducing hearing loss in recycling workers (e-waste, scrap, and other waste). By Carlson K, Morata T, Hughes SE, Afanuh SE. Cincinnati, OH: U.S. Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2025-100

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For More Information

More information about occupational noise exposure can be found at <https://www.cdc.gov/niosh/noise/index.html>

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DOI: <https://doi.org/10.26616/NIOSH PUB2025100>

DHHS (NIOSH) Publication No. 2025-100

December 2024