Focus Four for Health

An Initiative to Address Four Major Construction Health Hazards

Guidance Document

Developed by the AIHA Construction Committee

AIHA®

Protecting Worker Health

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Flux core welding.

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EXECUTIVE SUMMARY

The American Industrial Hygiene Association Construction Committee developed this guidance document to raise awareness about health hazards in the construction industry. AIHA represents the professionals and experts dedicated to identifying, evaluating, reducing, controlling and preventing occupational health hazards.

The key target audience is construction contractors. The key messages are the following:

(1) health hazards can have significant impacts on workers and businesses;

(2) efforts to reduce health hazards typically lag behind those for safety hazards on many construction worksites; and

(3) health hazards can be effectively controlled, just as safety risks are.

The guidance uses the successful Occupational Safety and Health Administration Focus Four program as a template. That program targets the four top construction safety hazards. This guidance complements that effort by presenting four prevalent health hazards for targeted attention:

(1) manual material handling,

(2) noise,

(3) air contaminants and

(4) high temperatures.

The guidance document provides a section for each health hazard to describe why each is important and to provide practical and specific steps that employers and construction stakeholders can take to recognize, reduce and control exposures.

Partnerships represented an important aspect of the Focus Four approach. The guidance document concludes by asking, *What can you do?* It includes ideas for those groups that impact and influence construction employers and employees: trade associations, labor unions, insurance providers, state and federal OSHA offices, industrial hygienists, safety professionals and consultants. We hope these groups find the guidance presented here helpful to further improve health conditions in the industry.

THE REASONS BEHIND FOCUS FOUR FOR HEALTH

Who is this for?

This guidance is for the construction employers and employees who build our homes, roads, bridges and buildings — particularly the many small and medium-sized firms common to the construction industry. The intended audience includes those performing new construction, those involved with renovations and those whose work is ongoing maintenance of buildings and structures. This type of work shares key characteristics: worksites vary, work conditions vary, and time spent per task varies.

The key message is that construction *health* risks that can harm employees and businesses are often overlooked. Just as safety risks are controlled on construction sites, health risks can also be controlled. This guidance document focuses on four important health hazards common throughout the industry. It explains why they are important, provides key points and messages for each and suggests specific actions that can be taken to reduce and control exposures.

Reaching many small and medium-sized construction employers and their employees is challenging. This guidance document lends itself to partnership activities among groups that regularly interact with construction employers: trade associations, labor unions, insurance providers, state and federal OSHA offices, industrial hygienists, safety professionals and consultants. We encourage these groups and individuals to use the guidance presented to further improve health conditions in the industry.

AIHA represents the professionals and experts dedicated to identifying, evaluating, reducing, controlling and preventing occupational health hazards. The AIHA Construction Committee prepared this guidance document and hopes it will be used to raise awareness about construction health hazards and to increase activities to address them.

What is the current situation?

Most U.S. and Canadian construction projects incorporate programs to prevent workplace injuries, and workplace safety is recognized as an important part of every project. Considerable efforts are made to identify and control safety hazards to prevent workplace injuries. Many construction employers embrace a "zero injuries" goal. When injuries do occur, investigations are undertaken to discover causes and to make sure such injuries do not happen again.

Health hazards do not get as much attention or effort on many construction worksites, yet health hazards, such as noise or air contaminants, are common. Take the following examples:

- When asked, more than half of construction workers reported they were regularly exposed to vapors, gas, dust or fumes at work twice a week or more — double the rate for all industries combined.[1]
- A poll of working adults found construction and workers in outdoor occupations were almost twice as likely as other workers (43 percent versus 22 percent) to say there was something about their workplace they think may be harmful to their health.[2]
- Almost three-quarters of construction workers in a 2011 study were found to be exposed to noise levels above the recommended exposure limit set by the National Institute for Occupational Safety and Health.[3]
- In an assessment of the overall health risk to workers after a career in construction, the risk for developing an occupationally related disease over a lifetime in a

[1] National Center for Health Statistics. 2010 National Health Interview Survey Occupational Health Supplement. Calculations by CPWR Data Center.

[2] NPR, Robert W. Johnson Foundation, Harvard School of Public Health. 2016. *The Workplace and Health*. https://www.rwjf.org/content/dam/farm/reports/surveys_and_polls/2016/rwjf430330, p. 13.

[3] Neitzel R, Stover B, and Seixas N. 2011. Longitudinal assessment of noise exposure in a cohort of construction workers (Table 1). *Ann. Occup. Hyg. 55(8)*:906-916. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3243919/.

construction trade was two to six times greater than for nonconstruction workers.[4]

Occupational illnesses can have a significant impact on construction workers and their families. These illnesses and resulting disorders can cut careers short, cause pain and disability, and cause premature death. If you think of workplace injuries as the visible "tip of the iceberg" for on-the-job hazards, then occupational illnesses represent the much larger — but hidden — hazard.

National estimates suggest that about 10 times as many fatal occupational illnesses occur compared with fatal occupational injuries.[5] The costs of these illnesses — whether shouldered by workers and their families, borne by employers affected by lost productivity or passed along to taxpayers in the form of higher disability costs — also tend to be overlooked.

The good news is that work-related health problems are preventable. Managing health risks is no different from managing safety risks. The purpose of this Focus Four for Health guidance document is to raise awareness about health hazards and to describe practical steps employers can take to address four common construction industry health hazards.

Why do health efforts lag those for safety?

People are much more aware of workplace safety and injury than they are of occupational health. When awareness is low, little is done to reduce health hazards. Why is health hazard awareness low? Three main factors contribute to low awareness about health hazards:

Seeing Is Believing

Safety gets more attention because injuries and safety hazards are easier to notice, or see. The hazard posed by an unguarded roof edge is directly observable with the naked eye. If an injury occurs, it happens right on the site. It typically is obvious to the injured person, to coworkers and to supervisors. Along with being more visible, safety hazard and injuries are usually common enough to be recognized.

Health hazards tend to be much less observable. Odor and visibility are unreliable indicators of how much of a potentially hazardous chemical might be in the air. When dust clouds or loud noises are noticeable, they may be dismissed as "just part of construction" because awareness of the health hazard potential is low. The situation is similar to how unguarded edges and other safety hazards were considered "just part of construction" before the increase in recent job safety-focused efforts related to fall prevention.

When an injury occurs on the job, its effect is immediate. That is not often true for occupational illnesses. It is true that poisoning from carbon monoxide or another substance can have immediate effects, but many occupational illnesses are *chronic* in nature. This means it takes time after exposure for the illness to develop, so the employee may not develop symptoms until months or even years later.

Unlike injuries, when illnesses occur, the link between them and work are not always obvious to the worker, co-workers or supervisors. The delay between exposure and symptoms — and the likelihood of working on multiple jobsites and for other employers in the meantime — makes it difficult for workers and employers to see the connection to a workplace health hazard. Off-the-job exposures (e.g., from certain hobbies) can also complicate the picture.

Another reason occupational illnesses are not *seen* is the symptoms and ailments usually overlap with other common illnesses. A worker could develop nerve damage from solvent exposure at work — or from medications or traumatic injury. It is difficult to determine the exact cause. Only a few types of occupational illness have either unique signs or symptoms

[4] Ringen K, Dement J, Welch L , Dong X, Bingham E, and Quinn P. 2014. Risks of a lifetime in construction. Part II: Chronic occupational diseases. *Am. J. Ind. Med. 57(11)*:1235-1245. https://onlinelibrary.wiley.com/doi/pdf/10.1002/ajim.22366.

[5] Leigh JP. 2011. Economic burden of occupational injury and illness in the United States. December 2011. *The Milbank Qtrly. 89*:4:728-772. https://onlinelibrary.wiley.com/doi/full/10.1111/j.1468-0009.2011.00648.x.

or are caused only by workplace exposures. For example, mesothelioma is a type of cancer caused only by asbestos.

Because occupational illnesses are not often immediately recognizable, training on recognition is critical. Workers and supervisors need hazard communication and other training about health hazards to alert them that they could be at risk. Common sense alone is not enough to warn of unseen dangers.

There are also many opportunities for making health hazards more attention-worthy on the job, such as noting whether proper protective measures are in use during the completion of certain high-risk tasks.

Mixed Signals From Regulations and Inspections

When workplace safety inspectors from regulatory agencies or insurance companies visit construction worksites, they usually examine injury records and closely check for well-recognized safety hazards such as falls from heights or cave-ins from excavations. Many safety-related regulations exist, and safety is emphasized during compliance and consultation visits. The high visibility given to safety reinforces high awareness. The message to construction employers and workers is clear: Safety is important.

Safety inspectors do look at site-recorded illnesses and can examine safety data sheets and hazard communication programs for information about chemical products and precautions used on the jobsite. Hazard communication is one occupational health-related standard cited among the top 10 OSHA violations for construction.[6] Safety inspectors can also make referrals for health inspections.

Overall, there are fewer health regulations and fewer health inspections in construction. Only about 7 percent of all OSHA construction inspections are for health, about one-third the 20 percent rate for general industry.[7] This

Photo: Jason McInnis Boilermakers (IBB).

inadvertently sends a message that health hazard prevention is not a priority for construction work. The low visibility of health reinforces low awareness.

Despite these mixed signals, health hazards are real. Occupational health professionals and regulatory agencies must work together to better target construction health issues and improve health-related messages conveyed to construction industry employers and workers.

Mixed Signals From a Lack of National Statistics

National reports are published every year describing the top causes of traumatic injuries within each industry sector. Construction stands out as having a large number of fatal injuries and higher rates of traumatic injuries than most other industries. These reports have a *ripple* effect as construction trade associations and labor organizations highlight the

[6] OSHA Directorate of Construction. *Top 10 Most Frequently Cited Construction Violations – 2018* (as of Sept. 30, 2018). https://www.osha.gov/doc/.

[7] OSHA Enforcement and Injury Costs – OSHA Enforcement of Construction Safety and Health Regulations: Inspections. Chapter 52 in *The Construction Chart Book.* CPWR – The Center for Construction Research and Training. 2013. CPWR chart book, 6th ed. 2018. https://www.cpwr.com/chart-book-6th-edition-osha-enforcement-and-injury-costs-osha-enforcement-construction-safety-and.

findings and emphasize those specific to their trade and their membership. They get the information out to end-users, which raises awareness and reinforces the importance of workplace safety.

Fewer occupational illnesses are reported, but because they are much more difficult to track, we know they are underreported. Federal agencies acknowledge national statistics do not provide an adequate picture of the number and types of occupational illnesses that occur.[8] This means health-related exposure and illness data do not receive a similar spotlight each year, and there is no awareness-raising ripple effect. This lack of ongoing attention year after year creates the impression that health hazards are not a major issue for construction.

How can we turn this around?

We must raise awareness about health hazards in construction. Awareness provides the motivation for construction employers and industry groups to act and better address health hazards.

The number of injuries in the construction arena has decreased. Safety strategies such as prejob planning, 10-hour outreach training and the use of competent persons have played a major role in that reduction.[9] So has OSHA's Focus Four approach. We urge the same strategies be applied to health hazards to create a Focus Four for Health for construction. The approach is described in the following section.

[8] The U.S. Bureau of Labor Statistics has "long acknowledged that some conditions that are difficult for employers to relate to the workplace are not adequately recognized and reported during a calendar year (for example, long-term latent illnesses) and are believed to be understated" in published illness measures. "Employer-Reported Workplace Injuries and Illnesses – 2015," BLS news release, Oct. 27, 2016. https://www.bls.gov/news.release/archives/osh_10272016.pdf, p. 5.

[9] The term "Competent Person" is used in many OSHA and provincial standards and documents. An OSHA "competent person" is defined as "one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them" [29 CFR 1926.32(f)]. By way of training and/or experience, a competent person is knowledgeable of applicable standards, is capable of identifying workplace hazards relating to the specific operation, and has the authority to correct them. See https://www.ccohs.ca/oshanswers/legisl/competent.html for provincial definitions.

HOW CAN WE USE FOCUS FOUR TO MOVE FORWARD ON OCCUPATIONAL HEALTH?

OSHA developed the Focus Four initiative in 1994 to target the top four safety hazards in construction: (1) falls from heights, (2) electrocution, (3) crushing injuries (e.g., trench cave-ins) and (4) being struck by material or equipment. OSHA tailored its construction inspections to focus on these four hazards.

This initiative stimulated the construction industry to do likewise. As a result, new training materials were developed. Training time and toolbox talks on these topics increased for both employees and supervisors. Having a short list of priority topics provided a useful starting point for small and medium-sized employers to begin engaging with their employees on safety.

OSHA's Focus Four is widely viewed by industry stakeholders as a successful program. While more work needs to be done to reduce fatal and nonfatal injuries in construction, the trend shows a decline in injury rates. For example, the fatal injury rate was 15 per 100,000 full-time workers in 1995; in 2017 it was 9.5, about a 36 percent decline.[10]

The existing Focus Four targets only construction safety hazards. We now propose a sister effort to target four important and common construction health hazards.

Construction industry stakeholders are already familiar with the Focus Four concept, which should ease the way for initiating similar activities for health hazards. Focus Four also stimulated industry partnerships, and these hold the potential for greatly increasing useful activities to address health hazards.

What are the Focus Four for Health topics?

1. Manual material handling
2. Noise
3. Air contaminants
4. High temperatures

Each topic is described in more detail in this guidance document.

How were the four topics selected?

The original Focus Four safety topics were selected using national injury statistics with a focus on fatal injuries. Equivalent high-quality national illness statistics are not available. Instead, an AIHA Construction Committee workgroup consisting of industrial hygienists from the construction industry used the best available data and evidence to select priority topics. The workgroup considered these criteria:

- What is the severity of the health impact on construction workers?
- How many construction workers are likely to be affected?
- How many construction trades are affected?
- What is the level of awareness about this hazard?
- Are there solutions that employers can use to reduce exposures?

What type of information is provided for each Focus Four for Health topic?

Each Focus Four for Health topic section follows a similar format. Each includes boxes titled "*You should know …*" and "*Worksite story*" to convey key statistics and case studies. The outline for each section is described below:

What is the hazard?

This section describes how the hazard arises in construction and provides examples. It offers a simple explanation of how the hazard leads to health conditions and illnesses and notes common symptoms and delayed effects. The information is basic and straightforward. It is not intended to be a comprehensive discussion of all that is known about the hazard.

[10] BLS 1995 data from https://www.bls.gov/iif/oshwc/cfoi/cftb0062.pdf and 2017 data from https://www.bls.gov/news.release/pdf/cfoi.pdf.

What do Industrial Hygienists Do?

They evaluate health hazards. For example, industrial hygienists can measure respirable dust levels, shown by the blue bar, when concrete blocks are cut dry.

They also recommend controls, such as the local exhaust ventilation used here on the cut-off saw to greatly reduce dust levels (see blue bar).

From https://www.cdc.gov/niosh/topics/silica/cutoffsaws.html.

How severe are the health effects and how common are they?

This section offers additional information on the severity of the resulting illnesses and disorders and whether they can cause permanent effects. It reports on what is known about the extent of the exposures and illnesses in construction.

What trades are most commonly affected?

This section names the trades that are known to have exposure to these health hazards.

How should we look at the health hazard?

This section provides simple ways for employers and workers to think about the health hazard so it is more tangible. It offers practical suggestions on how to evaluate factors that can influence potential exposures.

What strategies can be used to control the hazard?

This section offers practical approaches that construction employers can take to reduce the target health hazard. Building on a proven safety approach, it starts with prejob planning and the use of a job safety analysis (see sidebar). It includes questions to use for prejob planning. The recommendations follow the hierarchy of controls approach (see sidebar).

What is the hierarchy of controls?

Not all approaches for addressing safety and health are created equal. For example, taking steps to eliminate the hazard is more protective — and cost effective — than relying on the use of personal protective equipment around the hazard. The hierarchy of controls puts all the strategies in a ranked order so the most preferred options are always to be considered first:

1. **Elimination**: Physically remove the hazard.
2. **Substitution**: Replace the hazard with a safer alternative.
3. **Engineering controls**: Protect users via control equipment such as local exhaust ventilation or noise enclosures.
4. **Administrative controls**: Change practices via warnings and procedures.
5. **Personal protective equipment**: Protect users via safety equipment.

Regulations and Guidance

This section describes the most relevant U.S. and Canadian regulations and guidance. It also provides good practice recommendations, which is important for the cases where existing regulations are out of date or inadequate.

How can trade groups help?

This section provides specific suggestions for construction industry group activities. These groups play an important role in safety and health. They serve as intermediaries to employers and workers and play influential roles as information conduits. They are excellent partner candidates for Focus Four for Health initiatives.

How can an industrial hygienist help?

The overall guidance is based on the steps employers can take on their own to improve health for construction workers; however, industrial hygienists can provide valuable assistance. This section describes specific areas in which industrial hygienists can help.

Takeaway Messages

This section recaps important messages relevant for the specific hazard. These messages include topics useful for safety and health professionals to discuss with employers and for instructors to highlight during training.

What is a JSA?

A job safety analysis is a simple technique that focuses on job tasks as a way to identify and address hazards before they occur. It focuses on the relationship between the worker, the task, the tools and the environment. It asks supervisors and workers to identify the basic steps to complete the job; the potential hazards that could occur at each step; and the safest way to do the job, including any controls or safety gear needed. Performing a JSA before completing a task and putting it in writing promotes good planning and safe work procedures.

While JSAs are most often undertaken for safety, the same approach works for health hazards. The more generic term "job hazard analysis" or "job hazard breakdown" is sometimes used. See OSHA 3071 and OSH Answers: Job Safety Analysis for additional information.

Additional Resources

Each Focus Four for Health hazard section concludes with a list of other useful resources.

FOCUS FOUR FOR HEALTH: MANUAL MATERIAL HANDLING

What is the hazard?

Construction involves hard, physically demanding work such as lifting and lowering heavy loads or pushing and pulling difficult-to-move objects. Some work involves awkward postures, such as work done overhead; in a stooped-over position; or in bending, pivoting, twisting or cramped positions. Sometimes a task must be repeated many times while handling heavy or vibrating tools.

These conditions can contribute to overexertion, when the body is pushed beyond its natural capacity. The biomechanical forces created can cause injuries to the soft tissues, muscles and tendons. A single overexertion may not lead to pain or other signs of injury. But as that physically demanding work is repeated day after day, construction workers might start noticing pain or stiffness. Or the repeated trauma might finally catch up to workers, leading to a single event that "blows out their back" (or their shoulder, arm or other bodily part). These injuries, caused by manual material handling, are called musculoskeletal disorders (MSDs). They share characteristics with basic injuries, but also with illnesses, given that they can take longer to develop.

This Focus Four topic spotlights the task known to be responsible for the largest proportion of overexertion-related MSDs: manual material handling. This activity can be defined as the use of bodily force to lift or put down, pull, push, carry, move, support or hold in position any type of load, including materials, equipment or other objects.

How severe are the health effects and how common are they?

MSDs range from temporary minor sprains and strains to permanent injuries that impair the worker's movement or activity, shorten construction careers, and lead to chronic lifetime pain and related problems. The parts of the body most commonly affected include the back, shoulder, knee, hand and arm. These disorders affect construction workers of all ages. Young workers may unknowingly take on higher risks when they shoulder the burden from older injured workers or because they feel pressure to prove themselves as good and strong workers.

The serious nature and impact of MSDs cannot be underestimated:

- There are no straightforward medical remedies for MSDs.
- MSDs can be very painful, and doctors often prescribe pain medication to help workers deal with the pain. Employees can become addicted to painkillers, even at prescribed doses, leading to dependency problems that can spiral into many other problems.
- No information is available about the incidence of opioid use by injured construction workers, but when Massachusetts Department of Public Health researchers looked at the occupations of workers who died from opioid-related overdose deaths during the years 2011 to 2015, they found that (1) construction had the highest overall number of deaths of all industries and (2) the rate of overdose deaths was six times higher than the average industry rate. The researchers stated the following:

You should know …

Overexertion and bodily reaction is the second leading cause of nonfatal construction injuries involving days away from work. The leading cause (37 percent) of work-related overexertion MSDs in construction is for pushing, pulling holding, carrying and catching, followed by lifting (30 percent).

Many industries have reduced the weight of manually lifted materials to fewer than 50 pounds. Yet loads weighing 80 pounds or more are still common in construction.

Sources:

"Musculoskeletal Disorders in Construction and Other Industries," *The Construction Chart Book*, p. 48. CPWR, 2018.

2015 Risk Outlook: Prescription Opioid Abuse: Risk Factors and Solutions. CNA Insurance Co., 2015.

The construction industry stands out in this study as having both a high rate and number of opioid-related overdose deaths. These findings are consistent with previous reports that opioids are widely used for pain management following work-related injuries and suggest these injuries and the need to work while in pain may contribute to the use and potential misuse of opioids.[11]

- In addition, a study of Ohio construction workers found that between 2010 and 2016, they were seven times more likely to die of an opioid overdose. NIOSH found construction occupations had the highest rates for drug overdose deaths (and for both heroin-related and prescription opioid-related overdose deaths) during the 2007-12 period.[12,13]
- MSDs are prone to recur and can lead to early retirement or disability. For example, MSDs were found to be the leading cause of sheet metal worker disability (47 percent of award cases), more than four times that for injuries.[14] Middle-aged workers who have severe low back pain and engage in physically demanding work, such as construction, are much more likely than other workers to leave the industry due to disability.[15]
- MSDs are surprisingly costly. Costs to employers range from workers' compensation and medical expenses to intangible costs from losing experienced workers. Workers are affected by medical costs and loss of earning ability if they must retire early or go on disability. Nationally, low back and neck pain from workplace and nonworkplace causes together rank as the *second-highest* source of health care spending among all types of health effects for those between the ages of 45 and 64, and as the *third-highest* source for those in the 20-to-44 age group.[16]

Worksite story

A drywall carpenter was diagnosed with tendinitis. He began to feel pain on a job where he had lifted and carried 12 10-foot sections of drywall up a 20 step stairway and then installed them.

Drywall is awkward to lift. The weight can vary depending on the sheet's dimensions:

- A 3/8-inch 4 x 10 foot piece weighs about **56** pounds.
- A 5/8-inch 4 x 10 foot piece weighs about **88** pounds.
- The heaviest sheets can exceed **120** pounds.

Use of dollies, drywall lifts and jacks can reduce manual handling risks.

Source: NIOSH Workplace Solutions: Preventing Injuries From Installing Drywall, at https://www.cdc.gov/niosh/docs/wp-solutions/2006-147/pdfs/2006-147.pdf, p. 2.

[11] Massachusetts Dept. of Public Health. "Opioid-related Overdose Deaths in Massachusetts by Industry and Occupation, 2011–2015," press release Aug. 8, 2018. https://www.mass.gov/news/department-of-public-health-taking-steps-to-keep-job-related-injuries-from-leading-to-opioid and link to https://www.mass.gov/doc/opioid-related-overdose-deaths-in-massachusetts-by-industry-and-occupation-2011-2015/download.

[12] Dissell R. "Ohio construction workers seven times more likely to die of an opioid overdose in 2016." *Cleveland Plain Dealer,* Nov. 7, 2017. https://www.cleveland.com/metro/index.ssf/2017/11/ohio_construction_workers_seven_times_more_likely_to_die_of_an_opioid_overdose_in_2016.html.

[13] Harduar ML, Steege AL, and Luckhaupt SE. 2018. Occupational patterns in unintentional and undetermined drug-involved and opioid-involved overdose deaths — United States, 2007–2012. *Morb. Mortal. Wkly. Rep. 67*:925-930. http://dx.doi.org/10.15585/mmwr.mm6733a3.

[14] West GH, et al. 2016. An analysis of permanent work disability among construction sheet metal workers. *Am. J. Ind. Med. 59*:186 195. http://onlinelibrary.wiley.com/doi/10.1002/ajim.22545/full.

[15] Welch LS. 2009. Improving work ability in construction workers - let's get to work. *Scand. J. of Work, Environ. & Health 35(5)*:321-324. file:///C:/Users/m7gil/Downloads/321_editorial%20(2).pdf.

[16] Dieleman JL, et al. 2016. US spending on personal health care and public health, 1996–2013. Figs. 3 and 4. *JAMA 316(24)*:2627-2646. https://jamanetwork.com/journals/jama/fullarticle/2594716.

MSDs are a major problem — accounting for about a third of work-related injuries in construction and about half of all workers' compensation costs. Each year, more than 20,000 construction workers suffer from lost workday injuries due to sprains and strains. Back injuries are the most common injury in construction.[17]

In summary, not every construction worksite MSD is caused by manual material handling, but it is *the main cause* and an important target of the Focus Four effort.

What trades are most commonly affected?

Manual handling hazards affect every construction trade. For example, laborers frequently lift, carry and position materials. Masons and bricklayers are constantly lifting and placing mortar, bricks and block. (For example, a bricklayer handling 200 concrete masonry unit blocks per day, each weighing 38 pounds, will lift the weight of more than five Ford F-350 pickup trucks each week.)[18]

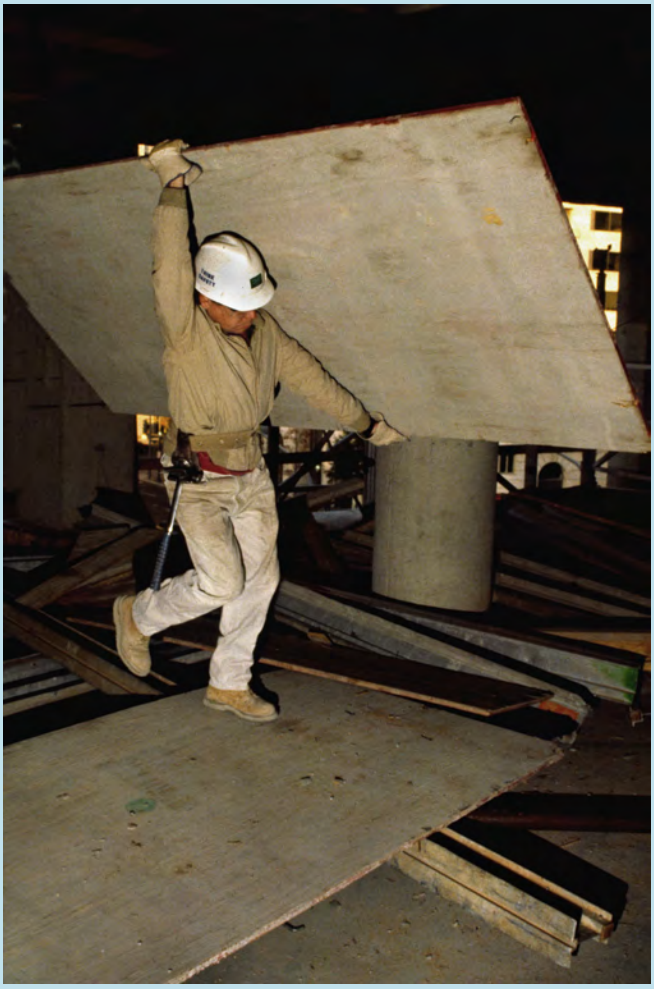
Glaziers and glazing contractors lift and carry awkward, heavy and fragile materials. Drywall installers handle and lift awkward and heavy drywall materials. Sheet metal workers, electricians and pipefitters perform much of their work in locations above ceiling level and must handle and position materials overhead. Demolition workers use heavy tools, such as jackhammers and sledgehammers.

Masonry and concrete work are the trades known to have the highest rates of overexertion injuries involving days away from work.

How should you look at manual material handling overexertion?

Consider how each work task will be performed, then consider the extent to which the following list of five common *risk factors* applies. The results represent the exposure potential, and higher exposure means an increased

Manual Material Handling



Drywall manual handling risk factors: weight, handling ease and awkward postures.
Photo: Earl Dotter.

[17] Back Injuries in Construction and Other Industries. Chapter 48 in *The Construction Chart Book*. CPWR – The Center for Construction Research and Training. 2013. http://www.cpwr.com/sites/default/files/publications/5th%20Edition%20Chart%20Book%20Final.pdf.

[18] Moraski P, and Watters M. "Lift teams share the load." *Occup. Health & Safety*, Nov. 2, 2009. https://ohsonline.com/Articles/2009/11/02/Ergonomics-Lift-Teams-Share-the-Load.aspx?Page=1.

likelihood of overexertion-related problems. An easy way to remember is to ask ***W-H-A-T PACE***?

Weight: The heavier the load the higher the risk.

Handling ease: Difficult-to-maneuver loads (e.g., no handles or cannot be carried close to the body, loads with contents likely to move) are higher risk. Also, loads to be handled on uneven or slippery surfaces are higher risk.

Awkward postures: Loads that require postures such as stooping, reaching, twisting, bending or kneeling are higher risk.

Time/distance: Loads that require a longer time to handle or a longer carrying distance (they go together) are higher risk.

PACE: Handling many loads per shift is a risk factor.

A useful NIOSH checklist for lifting, carrying, pushing or pulling that includes specific weights, distances, and times is provided in the Additional Resources section.

What strategies can be used to control this hazard?

Plan Ahead to Identify and Reduce Potential Problems

Make sure your job safety analysis includes manual handling hazards so you can set up the jobsite to minimize overexertion risks. In addition to considering the common risk factors listed above, ask questions such as these before the job starts:

- Where will materials be delivered in relation to where they will be used? Have materials delivered as close as possible to where they will be used. Workers should not have to move materials repeatedly before use. Reduce handling repetition.
- How much will the materials weigh? Find out your options for purchasing lighter units.
- How will materials be stored? Storing heavier materials at knee-to-waist height makes them much easier to access and minimizes awkward handling postures.
- How will materials be moved? Plan to have material handling equipment (e.g., carts, dollies, lifting tables) readily available and in good working order. Ensure clear, level pathways for moving materials and using material handling equipment.
- Will the work involve awkward postures? If so, can those tasks be set up differently to eliminate or reduce this hazard?
- What tools will be used? New types of tools and mechanical devices (e.g., overhead drill rigs) are available to minimize overexertion for specific tasks. When buying tools and equipment, look for tools that are lighter, are designed for comfortable grip, produce less vibration and require less force to operate.
- Examine the work process itself. Is it efficient? Will it risk worker overexertion? How could the job be made easier so workers work smarter, not harder? Get input from workers on possible solutions. Studies have shown working smarter reduces the risk of injury and improves productivity.

Planning resources and checklists are included in the Additional Resources section.

Implement Good Control Practices

Use the JSAs developed from the above questions to raise awareness among supervisors and workers and to demonstrate the proper work procedures and controls for reducing overexertion. For example, clearly identify which tasks require equipment, such as lifting tables, and demonstrate how they are used.

Set rules for manual material handling, such as no material heavier than 50 pounds should be lifted by only one employee.

Check on the job to ensure workers are using the recommended procedures, which should be as efficient as the riskier procedures they replace. If they are not, workers might not use them. When introducing new tools or techniques, give workers a trial period to get used to them after training.

[19] OSHA did issue an Ergonomics Program Rule in 2001. However, it was revoked via the Congressional Review Act. That law also prohibits the reissuing of the rule in substantially the same form or the issuing of a new rule that is substantially the same, unless specifically authorized by a new law. This prohibition presents a challenge to developing new rules to address this topic.

Otherwise, workers may reject the new tools or techniques as too different from what they are accustomed to.

Regulations and Guidance

United States

No OSHA standards address manual material handling or musculoskeletal disorders. It is unlikely OSHA will be able to develop rules on this health hazard in the future.[19] Employers that build their safety and health programs solely on compliance will miss this important hazard.

Guidance materials are available, such as NIOSH's guidelines for manual material handling, the NIOSH Lifting Equation App and the American National Standards Institute voluntary consensus standard ANSI/ASSE A10.40, "Reduction of Musculoskeletal Problems in Construction." See the Additional Resources section links.

Canada

Requirements for lifting and handling loads are set forth in the occupational health and safety legislation of Canadian provincial and territorial jurisdictions, as well as the federal Labour Program (for worksites that are federally regulated). Guidance materials are available from several provinces. For example, Ontario, Quebec and British Columbia all have materials that address manual material handling. See CANOSHWEB and the Additional Resources section for a list and links.

Good Practice

Construction employers should take steps to incorporate manual material handling hazards in their safety and health programs and JSAs. Guidance materials can help employers evaluate risk factors and reducing overexertion exposures.

How can trade groups help?

The many trade-specific employer and employee organizations in construction can work together to target manual material handling task hazards. For example, a working group could identify the top four manual handling tasks associated with overexertion and MSDs in that specific trade. Dissemination of specific guidance, best practices and training materials tailored to the trade can help address this Focus Four hazard.

How can an industrial hygienist help?

Industrial hygienists can assist employers with identifying tasks likely to cause overexertion. They can provide specific recommendations on better procedures, materials and tools to reduce risks. They can help set up employer programs and train supervisors on how to perform better JSAs to address manual material handling risks. They can also provide oversight and review to ensure effective programs.

Takeaway Messages

1. Construction work is very physical, which puts employees at high risk for overexertion. Manual material handling is the major cause of overexertion.
2. Overexertion can lead to developing MSDs, which are less obvious to workers or supervisors when they occur than injuries, such as cuts or abrasions, and are known to be underreported. Employee and employer awareness about these types of disorders is generally low.
3. MSDs typically result in time away from work and significant costs. They account for the costliest injuries in construction.
4. The impact from MSDs is considerable. The resulting conditions can be long lasting, which can cut careers short and disrupt families. The need to continue working while in pain can lead to use of pain medication and accompanying problems such as addiction. Studies have found construction workers with MSDs are more likely to retire early or go on disability.
5. MSDs are preventable. Risks can be reduced significantly by implementing proper planning, employing new tools and equipment, and identifying ways to work smarter, not harder.
6. Worker involvement in helping identify hazardous tasks and potential solutions is important, particularly in gaining acceptance for changes you want to make.

7. Reducing manual material handling hazards can also improve the image of the construction industry, help attract new employees (including increasing roles for women in the trades), and help retain the most experienced and productive employees as they age.
8. Once you gain experience tackling manual material handling, consider expanding your efforts to look at other types of MSD risk factors, such as vibration or tool use.

Additional Resources

OSHA has a topic page on preventing MSDs at https://www.osha.gov/SLTC/ergonomics/. See also the OSHA Alliance fact sheet on "Strains, Sprains, and Material Handling Tips for Employers."

NIOSH publishes three resources: "Ergonomic Guidelines for Manual Material Handling"; "Simple Solutions Ergonomics for Construction Workers" with 20 tip sheets; and "Simple Solutions for Home Building Workers." NIOSH also has an app for calculating the overall risk index for single and multiple manual lifting tasks:

ANSI/ASSE Standard A10.40-2007 (R2018), "Reduction of Musculoskeletal Problems in Construction," provides a useful template for addressing MSDs.

WorksafeBC provides information, and two calculators – one for lifting/lowering, and one for pushing/pulling/and carrying at https://www.worksafebc.com/en/health-safety/hazards-exposures/lifting-handling. There is also a short video "Lifting in the Workplace" available in nine languages. A lifting calculator is provided at http://worksafebcmedia.com/misc/calculator/llc/.

Ontario Ministry of Labour has a "Prevent Musculoskeletal Disorders (MSDs) at Construction Projects" page.

Ontario's Infrastructure Safety and Health Association provides guidance materials such as its "Resource Manual for the MSD Prevention Guideline for Ontario": general site is at http://www.ihsa.ca

CPWR - The Center for Construction Research and Training provides general information about preventing MSDs in construction at http://elcosh.org/document/1648/d000560/preventing-muskuloskeletal-disorders-in-construction-workers.html. This includes a "Best Built Plans - Manual Material Handling Tool".

Quebec's Institute for Research in Occupational Health & Safety (IRSST) has published a "Planning Tool for Safe Manual Material Handling."

Liberty Mutual insurance company's Manual Materials Handling Tables allow users to plug in weights and lifting distances to find out the percentage of men or women who can perform such a task without overexertion.

AIHA provides a useful "Ergonomic Assessment Toolkit."

The U.K. Health and Safety Executive provides a variety of materials and tools on manual handling at http://www.hse.gov.uk/MSD/manualhandling.htm, such as Manual handling assessment charts (the MAC tool).

NIOSH Hazard Evaluation Checklist for Lifting, Carrying, Pushing or Pulling

This checklist was developed by NIOSH researchers to provide a tool to quickly identify potential problem jobs. YES responses indicate conditions that pose a risk for developing low back pain. The risk goes up with each YES response. The checklist can provide ideas for follow-up, either to look more closely at the details of tasks or to identify solutions to move risk factors to the NO column.

Keep in mind, depending on unique aspects of particular jobs, additional risk factors might exist.

Risk Factors	YES	NO
1. General		
1.1 Does the load handled exceed **50 pounds**?		
1.2 Is the object difficult to bring close to the body because of its size, bulk or shape?		
1.3 Is the load hard to handle because it lacks handles or cutouts for handles, or does it have slippery surfaces or sharp edges?		
1.4 Is the footing unsafe? For example, are the floors slippery, inclined or uneven?		
1.5 Does the task require fast movement, such as throwing, swinging or rapid walking?		
1.6 Does the task require stressful body postures, such as stooping to the floor, twisting, reaching overhead or excessive lateral bending?		
1.7 Is most of the load handled by only one hand, arm or shoulder?		
1.8 Does the task require working in extreme temperatures, with noise, vibration, poor lighting or airborne contaminants?		
1.9 Does the task require working in a confined area?		
2. Specific		
2.1 Does lifting frequency exceed **five lifts** per minute?		
2.2 Does the vertical lifting distance exceed **3 feet**?		
2.3 Do carries last longer than **one minute**?		
2.4 Do tasks that require large sustained pushing or pulling forces exceed **30 seconds** in duration?		
2.5 Do extended reach static holding tasks exceed **one minute**?		

Source: Ergonomic Guidelines for Manual Material Handling, Appendix B, page 53.

FOCUS FOUR FOR HEALTH: NOISE

What is the hazard?

Construction operations are noisy. High noise levels damage the sensory cells inside the ear, resulting in hearing loss. Once damaged, these cells do not grow back, permanently reducing the person's ability to hear.

High noise levels can cause other health effects. Tinnitus is the most well-known. This "ringing in the ears" is the perception of sounds even when none are present. Growing evidence suggests high noise levels are linked to other harmful health effects, such as sleep disturbance, cardiovascular disease, hypertension, depression and impairment of balance.

In the workplace, noise levels that exceed 85 decibels are considered high enough to cause hearing loss. A simple rule of thumb is that when you must raise your voice to be heard when talking to someone an arm's length away from you the noise level is typically over 85 decibels.

The damage caused by high noise levels occurs gradually over time. It usually is not noticed by workers or employers until the damage is irreversible. The exception is that very high noise levels (130 to 140 decibels) can cause pain and hearing loss damage — even from a single brief exposure.

Most construction tools and activities create noise levels well over 85 decibels. Several can generate very high sound levels (130 to 140 decibels) that can cause damage to the ear instantaneously. Still, noise hazards tend to be overlooked on construction worksites: They are more often considered an annoyance or an obstacle to communication than an important health hazard.

Noise-induced hearing loss is the most common work-related illness in the United States. Each year approximately 30 million U.S. workers are exposed to noise loud enough to damage their hearing.

How severe are the health effects and how common are they?

While noise tends to be taken for granted on most construction projects, the impact of noise-related hearing loss on quality of life is considerable. There is no cure for hearing loss or tinnitus. Noise-induced hearing loss reduces the clarity of the sound, not just the volume, meaning that hearing aids do not effectively remedy the problem.

Hearing loss makes it difficult to enjoy talking with family members, friends and co-workers. It makes hearing phones, doorbells, smoke alarms, music or television difficult. Hearing loss means an inability to contribute to everyday conversations and social gatherings, which strains relationships. Adult hearing loss has been linked to isolation; loneliness; depression; and earlier onset of cognitive decline, such as loss of memory and thinking skills. Hearing loss can also contribute to job-related safety hazards — for example, if a worker cannot hear an approaching vehicle or a warning signal.

Tinnitus is often minimized as a health effect. But it can be a debilitating condition that negatively affects overall health and well-being by interfering with sleep, making concentration difficult and by causing anxiety in some individuals.

As stated by NIOSH, "Noise can hurt more than your ears". There is new research exploring links between noise and other important health outcomes, such as cardiovascular disease and high blood pressure.[20] Some individuals with

You should know …

Hearing loss is not always obvious without a hearing test. One study found that 42 percent of workers who claimed they had good or excellent hearing were found to have hearing loss when tested.

Source: CPWR. 2013. Noise-Induced Hearing Loss in Construction and Other Industries. http://www.cpwr.com/sites/default/files/publications/CB%20page%2049.pdf.

[20] Kerns, E and Masterson, E. 2018. NIOSH. Workplace Noise: More than just "All Ears". NIOSH Science Blog. June 28, 2018 at https://blogs-origin.cdc.gov/niosh-science-blog/2018/06/28/noise-effects/

noise-induced hearing loss report balance problems, and this is also an area of ongoing research. Effects on balance are important in construction, where falls are a major safety hazard.

In summary, noise is often taken for granted, but it can have a profound impact on construction worker health and well-being, especially in later years and during retirement.

What trades are most commonly affected?

Noise is present in every construction trade. These include highway and road construction; carpentry; power tool operations; pneumatic tool operation; heavy equipment operations; saws, drill and grinder operation; work near generators; sheet metal work; iron work; welding; operating engineer work; landscaping; residential construction; and sand or abrasive blasting.

You should know …

Hearing loss caused by exposure to noise is common among construction workers. One study found a lifetime probability of developing hearing loss averaging 60 percent among all trades, and up to 80 percent in some trades, such as welding.

A study of carpenters found that the average 25-year-old carpenter had already lost enough hearing that his or her hearing ability was about the same as that of a 50-year-old person who had not been exposed to noise on the job.

Source: Dement J, Ringen K, Welch L, Bingham E, Quinn P 2005. Surveillance of hearing loss among construction and trade workers at department of energy nuclear sites. *Am J Ind Med, 48*:348-358, https://www.academia.edu/26811529/Surveillance_of_hearing_loss_among_older_construction_and_trade_workers_at_Department_of_Energy_nuclear_sites.

Source: NIOSH. https://www.cdc.gov/niosh/topics/noise/factsstatistics/charts/chart-50yrold.html

How to Look at Noise

Noise intensity is measured in units of decibels — db, for short, or dBA using the "A scale" that is most relevant for human hearing. Unlike simple additive scales such as temperature, the decibel scale is logarithmic, to allow measurement of the remarkably wide range of sounds that humans can hear. This means an increase of 10 dBA is equivalent to a sound 10 times as strong in intensity. However, an increase of 20 dBA is equivalent to a sound intensity 100 times greater.

Understanding decibel measurements takes practice. For example, looking additively, the number 88 is just 3.5 percent higher than the number 85. But a noise level of 88 dBA is 100 percent higher — twice as loud — than a noise level of 85 dBA.[21]

An easy and effective way to look at noise is to think of a *noise clock*. The louder the noise, the shorter the permissible exposure time will be. To use a noise clock approach, first find out the noise levels associated with the tools and tasks being considered. Then consult the noise chart in the sidebar (or the one at the end of this section) to determine how long those tasks can be performed before overexposure to noise starts to occur.

As shown in the NIOSH *How to "Look" at Noise* chart, the exposure received from *8 hours at 85 dBA* is equivalent to the exposure caused by just *7½ minutes at 103 dBA*.

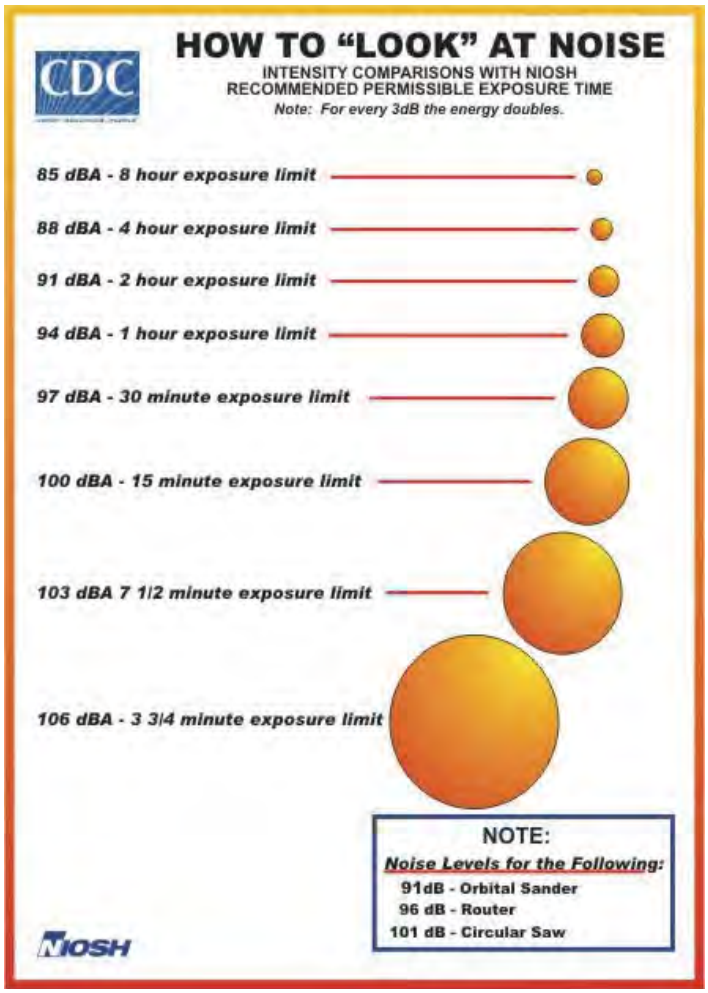
What strategies can be used to control this hazard?

Plan Ahead to Identify and Reduce Potential Problems

Make sure your JSA includes noise hazards so you can set up the jobsite to minimize noise exposures. Ask questions such as those below before starting the job. Planning resources and checklists are described in the Additional Resources section.

- What tasks are likely to create high noise levels?

[21] Our guidance uses the 3-dBA time-intensity doubling rate, which is the up-to-date approach considered the best predictor of noise hazards. It is recommended by NIOSH, the military and other groups. The OSHA noise standard relies on an older, less valid, 5-dBA doubling rate and an eight-hour time-weighted PEL of 90 dBA.



- What are the expected noise levels? Check your worksite for noise levels from various types of equipment and create an inventory of noisy equipment and tasks.
- Noise level information for many types of tools is available from vendors. Noise information associated with common construction tasks is also available (see Additional Resources at the end of this section). Noise levels can also be measured using an inexpensive sound level meter from an electronics store or even a smartphone app (see sidebar).
- How long will the task take? Perform a noise clock comparison. Does the allowable exposure time at the specified noise level exceed the expected task time? If so, overexposure will occur (see the example in the sidebar).
- Where will the tasks be performed? Will other workers be nearby?
- Can high-noise-level tasks be performed differently to reduce the noise level (e.g., using a quieter tool) or the duration of the task?
- If not, what type of hearing protection will be needed?

You should know …

Noise apps are available that allow users to measure noise in decibels using a smartphone. This means that front-line supervisors and employees can be empowered to evaluate noise levels, a practice sure to raise awareness of noise. It also enables users to confirm actions to reduce noise levels have been effective.

A smartphone app is not as accurate as a sound level meter, and this more accurate tool can be used for decisions such as compliance determinations or major noise reduction investments.

More information about noise apps and a free NIOSH noise app that has impressive accuracy can be found in these NIOSH blog posts:

http://blogs.cdc.gov/niosh-science-blog/2014/04/09/sound-apps/

https://blogs.cdc.gov/niosh-science-blog/2017/01/17/slm-app/

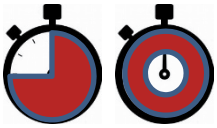
Prevent and Control

The most common approach to noise hazards on construction jobs is to provide hearing protection such as earplugs or earmuffs. This approach can protect the hearing of the wearer, but a better approach, using the hierarchy of controls, is to reduce the noise at the source via elimination or engineering controls. This approach protects everyone in the area.

EXAMPLE
Job that involves two noisy tasks:
jackhammering (2 hours) and lateral drilling (3 hours)

Expected jackhammering noise level is 100 dBA.

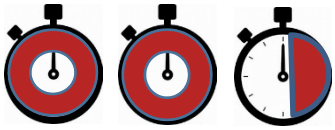
Noise clock overexposure at 100 dBA occurs after **15 minutes.**



1¾ hours overexposure

Expected lateral drilling noise level is 97 dBA.

Noise clock overexposure at 97 dBA occurs after **30 minutes.**



2½ hours overexposure

Planning is needed to reduce noise and/or provide hearing protection.

Photo: OSHA.

If you are new to noise reduction, a good way to get started is by focusing attention on the top five high-noise tasks on each construction project. This information should already be available from the JSA step. Taking steps to convert a 100-dBA task (for which overexposure occurs after 15 minutes) into an 88-dBA task (for which overexposure occurs after four hours) is a worthwhile effort.

- It may be possible to "buy quiet" or "rent quiet" to substitute less noisy tools for the task (see NIOSH reference materials on buying quiet in the Additional Resources section). Often the cost is comparable.
- Another approach is to isolate noisy equipment using sound absorbing materials or modify the equipment to reduce noise transmission.
- Restricted areas can be designated around noisy operations. The job can be set up to place louder equipment farther away from workers.
- Some equipment noise increases when maintenance is needed, so having a preventive maintenance program is another strategy to reduce noise.

As employers gain experience with this approach, they can expand efforts to go beyond the top five tasks to more comprehensively address overexposures.

Track, Train and Test

- Create an overall program to guide noise-control efforts and to raise awareness about the importance of noise control.
- Use the JSA to train supervisors and workers about hearing loss, task-specific noise levels and noise reduction procedures to be used.
- Use labels or stickers to help communicate noise levels of various tools.
- Provide proper hearing protection if noise levels and task duration indicate overexposures will occur (and if you cannot use other measures to adequately reduce the noise).
- Make sure workers know how to properly select and use hearing protection. Poorly fitting gear provides inadequate protection.

You should know …

Hearing protectors

Hearing protectors vary in their ability to reduce noise exposures. They come with noise reduction ratings (NRRs) to provide information on how much noise they can potentially reduce. The higher the NRR, the better the noise reduction.

However, a combination of testing issues and real-world experience means the NRR needs to be adjusted to estimate the degree of protection actually provided.

NIOSH recommends you adjust NRRs as follows:

- Earmuffs: Subtract 25% from the NRR
- Formable earplugs: Subtract 50% from the NRR
- All other earplugs: Subtract 70% from the NRR

EXAMPLE: For a 100-dBA noise exposure and choice of the following:

A) Earmuffs with an NRR of 29

B) Formable earplugs with an NRR of 28

Estimated noise exposures are as follows:

A. Wearing earmuffs	**B. Wearing earplugs**
Noise level	Noise level
= 100 – [29 – (25% of 29)]	=100 – [28 – (50% of 28)]
= 100 – [29 –7.25]	= 100 – [28 –14]
= 100 – 21.75	= 100 – 14
= 78.25 dBA	= 86 dBA

  - Emphasize that removing hearing protection for short periods (e.g., 10 minutes during an hourlong noise exposure) is enough to substantially reduce the overall protection.
  - Have a variety of different hearing protectors available and help employees choose the ones that best fit them and are most appropriate to the work (i.e., not providing too much or too little protection).
  - Communication is important in construction, and sometimes specialized hearing protection is a good solution. For example, active hearing protectors (with electronics), flat attenuation plugs (which do not cut out speech communication as much) and earmuffs with built-in communication systems are available.[22]
  - Manufacturers of hearing protection are often willing to provide information and training materials on proper use and fitting.
  - Develop a strict but fair enforcement policy for use of hearing protection where required.
  - Make sure all employees in those areas, including foreman and visitors, wear hearing protection as well.
  - Consider using wearable devices such as a badge clip noise indicator that lights up and flashes to warn the wearer of high noise levels and the need to wear hearing protection.[23]
- Provide hearing tests (also called audiometric tests) for employees regularly exposed to noise levels over 85 dBA and/or work with them to make sure their health benefits include an annual hearing test.
- Pre-employment hearing tests are also useful. Mobile testing services can visit worksites to perform hearing tests. Make sure workers understand the results and can compare them with results from previous tests.

Regulations and Guidance

United States

The OSHA noise standard for construction (CFR 1926.52) is 90 dBA as an eight-hour time-weighted average. It requires employers to implement administrative or engineering controls when noise levels exceed the standard, and to then provide PPE if these measures do not sufficiently reduce the exposures.

The standard, which originated in 1969, is considered out of date and insufficiently protective by safety and health experts because 29 percent of workers exposed to this level over a working lifetime would nevertheless experience hearing loss.[24]

OSHA improved protections for general industry workers in 1983 by issuing a hearing conservation standard requiring noise monitoring and hearing tests for workers exposed to noise levels over 85 dBA. However, the rule did not cover construction workers. OSHA issued a notice in 2002 to extend similar protections to construction workers but the effort did not lead to a proposed standard.[25]

At the state level, California, Oregon and Washington require construction employers to provide hearing tests.

The NIOSH recommended exposure limit for noise is 85 dBA as an eight-hour time-weighted average. NIOSH recommends employees exposed above this level participate in a hearing loss prevention program that includes hearing tests.

Canada

Noise exposure limits are set at the province and territory levels (and at the federal level for certain federally regulated worksites). The exposure limit is 85 dBA as an eight-hour

[22] These options are described in an OSHA Safety and Health Information Bulletin at https://www.osha.gov/dts/shib/shib122705.html.

[23] https://www.amazon.com/3M-Indicator-NI-100-Hearing-Conservation/dp/B006UKZ5BI#feature-bullets-btf.

[24] NIOSH. 1998. *Occupational Noise Exposure: Criteria for a Recommended Standard*, https://www.cdc.gov/niosh/docs/98-126/pdfs/98-126.pdf, p. 20.

[25] OSHA 2002. Hearing Conservation Program for Construction Workers: Advance notice of proposed rulemaking (ANPR); request for information and comment. *Federal Register 67*. (Aug. 5, 2002). pp. 50610-50618. https://www.osha.gov/laws-regs/federalregister/2002-08-05.

time-weighted average in every province and territory except Quebec, where the standard is 90 dBA.

Canadian hearing protectors must meet the Canadian Standards Association standard for noise reduction. Several provinces (e.g., British Columbia and Manitoba) also require hearing tests for noise-exposed employees.

Good Practice

Construction employers should use the 85 dBA standard to guide their efforts. They should use hearing conservation programs that include hearing tests for employees whose exposures exceed this level. Audiometric tests are widely recognized as a crucial component for protecting workers from noise.

How can trade groups help?

The many trade-specific employer and employee organizations in construction can work together to improve occupational health in construction by identifying and targeting the top four or top 10 high-noise operations specific to their trades. These groups already provide safety and health guidance and training materials, so they can readily disseminate noise reduction materials tailored to the trade to help address this Focus Four hazard.

How can an industrial hygienist help?

Industrial hygienists can assist employers with evaluating noise levels associated with construction tasks. They can provide options for reducing noise levels, help set up and guide employer programs, and train supervisors on how to perform better JSAs to address noise and to help with noise awareness efforts. Industrial hygienists can help employers select the most appropriate hearing protectors and can connect employers with groups that provide audiometric testing. Industrial hygienists can also provide oversight to ensure effective programs.

Takeaway Messages

1. Noise-induced hearing loss is 100 percent preventable, but once acquired, it is permanent and irreversible.
2. Typical construction work is noisy, and studies show working lifetime in construction involves a high likelihood of permanent hearing loss.
3. More progress could be made to reduce worker exposure to construction noise if awareness was higher. This can be achieved by the following:
   - Providing noise awareness training. Many good materials are available (see Additional Resource section) for toolbox talks and other uses.

You should know …

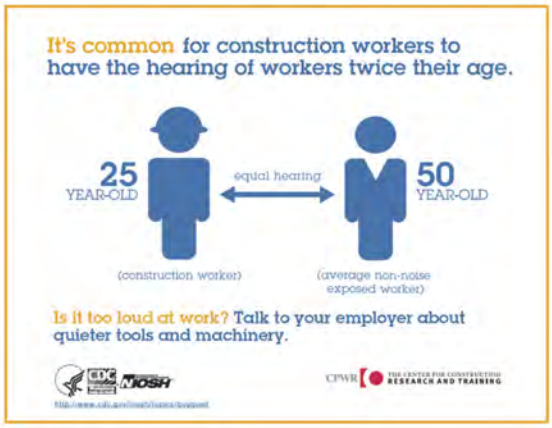
Hearing protection devices do not cost much and are easy to provide. Yet this does not translate into reliable protection without information about noise levels and good training.

One study found that while 86 percent of experienced construction workers on a site had been provided with hearing protection devices, only 25 percent had had any training on using hearing protection. The workers reported using the devices less than 10 percent of the time.

A study of construction apprentices — whose survey responses indicated they "always" used hearing protection devices in high noise — found the apprentices wore the devices only one-third of the time their exposures exceeded 85 dBA. When the researchers measured the actual noise reduction, they found that noise overexposure levels were reduced to below 85 dBA in only 20 percent of cases. The researchers reported better programs with training and hearing tests would help but recommended the industry also use simple noise controls to reduce noise levels.

Sources: Dineen, R., Reid, J., and Livy, P. Knock out noise injury: An evaluation of the influence of education and workers' understanding and management of noise hazards in the building and construction industry. *Noise Effects,* November 1998.

Neitzel, R., and Seixas, N. The effectiveness of hearing protection among construction workers. *J. Occup. Environ. Hyg. 2*:227 238 (2005).



- Measuring noise on the job. The availability of sound level meter smartphone apps means noise levels on every construction job can be measured to make available useful input about noise levels.
- Providing hearing tests through annual physicals or other means to provide objective information on hearing. This is critical because hearing loss is gradual. Workers are not likely to notice it until the damage is irreversible.

4. Prioritize the very highest noise levels. The 100-dBA level — for which overexposure occurs in just 15 minutes — is a useful boundary. Most supervisors and workers do not know overexposure occurs so quickly at this level. Many options are available for reducing noise level via procedures and controls. If your workers need to rely on hearing protection, it is critical you provide sufficient protection and training for everyone likely to be exposed, so they know to wear it during these loud tasks.
5. Noise off the job comes from sources such as motorcycles, music earbuds and headphones, and firearm use. Discussions about construction noise should acknowledge this fact. These examples can be used as reference points for sound levels and for off-the-job tips for hearing protection.
6. Reducing construction noise is important not only for workers but also for business. Performing work while creating less noise is marketable: Contractors who know how to reduce noise increase their competitive position. For many types of construction work, noise is one of the biggest sources of public complaints — from residential work in a suburban setting to commercial work in a city or near any school, hospital or church. Numerous counties and cities have begun to put in place and enforce construction noise codes. For example, the New York City noise code requires construction work to include a noise mitigation plan. Jackhammers must be fitted with noise-reducing mufflers and/or be used behind portable street barriers to reduce the sound impact in the area.

Additional Resources

OSHA noise information is available at https://www.osha.gov/SLTC/noisehearingconservation/construction.html.

OSHA also has a pocket guide on construction noise available at https://www.osha.gov/Publications/3498noise-in-construction-pocket-guide.pdf.

A downloadable presentation on OSHA's approach to construction noise is available at http://www.elcosh.org/document/1666/d000573/OSHA%2527s%2BApproach%2Bto%2Bnoise%2Bexposure%2Bin%2Bconstruction.html.

The NIOSH recommended exposure limit for noise can be found at https://www.cdc.gov/niosh/docs/98-126/pdfs/98-126.pdf.

NIOSH guidance on how to set up a "buy quiet" program is available at http://www.cdc.gov/niosh/topics/buyquiet/. A power-tool database that contains noise information for a variety of tools is available at https://www.cdc.gov/niosh/topics/noise/noise_levels.html. A simulated noise level meter is available at https://www.cdc.gov/niosh/topics/noise/noisemeter_html/default.html and a web page about noise control approaches in general at http://www.cdc.gov/niosh/topics/noisecontrol/default.html. Noise infographics useful for training and toolbox talks are available at http://www.cdc.gov/niosh/topics/noise/infographics.html.

The Electronic Library of Construction Safety and Health (eLCOSH) has a variety of construction noise resources available at http://www.elcosh.org/en/index.php?module=Search&and_filters[]=19.

Information on Canadian provincial and territorial noise exposure limits can be found at https://ccohs.ca/oshanswers/phys_agents/exposure_can.html.

WorkSafe BC provides materials, including a video, on noise at https://www.worksafebc.com/en/health-safety/hazards-exposures/noise.

The Alberta Occupational Health and Safety Code Explanation Guide addresses noise in Section 16. It provides much information and includes a discussion on how Canadian Standards Association hearing protector ratings compare to U.S. noise reduction ratings. See https://open.alberta.ca/publications/4403880.

The University of Washington created noise booklets for each major construction trade that describe the most common tasks and noise levels. See http://depts.washington.edu/occnoise/booklets.html.

The Federal Highway Administration Construction Noise Handbook is available at http://www.fhwa.dot.gov/environment/noise/construction_noise/handbook/handbook00.cfm.

Information on the New York City noise code is available at http://www.nyc.gov/html/dep/pdf/noise_code_guide.pdf.

ANSI/ASSE Standard A10.46-2013 (R2018), "Hearing Loss Prevention for Construction and Demolition Workers," is a task-based standard where noise controls and hearing protection are applicable to any task that exceeds 85 dBA. It provides a useful approach for developing a hearing loss prevention program.

This U.K. Health and Safety Executive tool shows the effect of briefly removing hearing protection: http://www.hse.gov.uk/noise/hearingprotection/index.htm?ebul=gd-cons/jul14&cr=29.

The Laborers Health and Safety Fund of North America web page on "Quieting Your Construction Site" is located at http://www.lhsfna.org/index.cfm/occupational-safety-and-health/noise/cncp-quieting-your-construction-site/.

The National Hearing Conservation Association website, http://www.hearingconservation.org/, provides several publications regarding hearing conservation.

The American Tinnitus Association has a useful "Understanding the Facts" topic page on tinnitus and its health impact.

A National Institutes of Health fact sheet on tinnitus is available at https://www.nidcd.nih.gov/sites/default/files/Documents/health/hearing/NIDCD-Tinnitus.pdf.

The Dangerous Decibels site on consumer and occupational hearing loss, located at http://dangerousdecibels.org/, offers educational materials to help people understand noise-induced hearing loss prevention.

NIOSH Recommended Exposure Limit Table for Estimating Noise Overexposure Times for Various Tasks

OVEREXPOSURE TIMES FROM 85 to 100 dBA	
Noise level	**Overexposure occurs after this time duration**
85	8 hours
86	6 hours, 21 minutes
87	5 hours, 2 minutes
88	4 hours
89	3 hours, 10 minutes
90	2 hours, 31 minutes
91	2 hours
92	1 hour, 35 minutes
93	1 hour, 16 minutes
94	1 hour
95	47 minutes, 37 seconds
96	37 minutes, 48 seconds
97	30 minutes
98	23 minutes, 49 seconds
99	18 minutes, 59 seconds
100	15 minutes

OVEREXPOSURE TIMES FROM 100 to 140 dBA	
Noise level	**Overexposure occurs after this time duration**
100	15 minutes
101	11 minutes, 54 seconds
102	9 minutes, 27 seconds
103	7 minutes, 30 seconds
104	5 minutes, 57 seconds
105	4 minutes, 43 seconds
106	3 minutes, 45 seconds
107	2 minutes, 59 seconds
108	2 minutes, 22 seconds
109	1 minute, 53 seconds
110	1 minute, 29 seconds
111	1 minute, 11 seconds
112	56 seconds
113	45 seconds
114	35 seconds
115	28 seconds
116	22 seconds
117	18 seconds
118	14 seconds
119	11 seconds
120	9 seconds
121	7 seconds
122	6 seconds
123	4 seconds
124	3 seconds
125	3 seconds
126	2 second
127	1 second
128	1 second
129	1 second
130-140	Less than 1 second

Source: Table 1.1, page 2, of Occupational Noise Exposure Revised Criteria 1998 (NIOSH).

FOCUS FOUR FOR HEALTH: AIR CONTAMINANTS

What is the hazard?

Many construction tasks create air contaminants. Dusts are created when materials are disturbed by cutting, grinding, drilling or sanding, or when dry materials such as cement are mixed. Metal fumes and gases are generated during hot operations such as welding and torch cutting. Vapors are created when solvents evaporate into the air during use. Exhaust gases and particulates are created when construction equipment and generators are used in work areas.

These air contaminants are inhaled by the construction workers performing the work. Inhaling air contaminants may lead to any number of short- or long-term health effects, depending on the toxicity of the material and the amount and duration of the exposures.

Some air contaminant exposures can be visible when present in the air at high levels. For example, dust can be seen when a chop saw is used to make a cut in a curb or concrete block. But most air contaminants have no reliable visual clues.

Even odor is unreliable. If a chemical has a good warning odor, "odor fatigue" occurs and the smell becomes less noticeable after it is initially detected. Moreover, for some chemicals the odor threshold exceeds the exposure limit. Therefore, significant exposures can occur without any obvious knowledge.

Unlike a workplace injury, such as a fall or puncture wound, the immediate consequence of a harmful workplace exposure may not show up as symptoms or illness right away. Many years may pass before serious health effects caused by air contaminants appear. This delayed onset makes understanding the risks posed by air contaminant exposures much more difficult for construction workers and employers. They also typically do not recognize the danger of short but high-intensity exposure tasks common to construction.

In general, awareness of the health implications of air contaminant hazards on construction projects is low. This represents an obstacle to taking simple steps that can improve conditions.

You should know …

A 2010 national survey asked this question:

Were you regularly exposed to vapors, gas, dust or fumes at work twice a week or more?

More than 50 percent of construction workers said "yes" — twice the average of all U.S. workers.

Source: National Health Interview Survey Occupational Health Supplement Construction Sector Profile, fig. 14. http://www.cdc.gov/niosh/topics/nhis/construction/consfig14.html.

How severe are the health effects and how common are they?

Because air contaminants are inhaled, the respiratory system (nose, throat and lungs) is commonly affected. Respiratory health effects range from short-term effects, such as irritation, to long-term problems leading to premature disability and death from occupational illnesses. These include asthma, breathing difficulties such as shortness of breath, lung scarring (called fibrosis), chronic obstructive lung disease (COPD) and lung cancer.

These illnesses may show up first as symptoms, such as breathing difficulties, or on medical exam results from X-ray and breathing tests (also called pulmonary function tests). Asbestos and silica are examples of materials that can cause both lung scarring (asbestosis and silicosis) and lung cancers. Asbestos also causes a cancer in the lining of the lung or abdomen (mesothelioma). Hexavalent chromium from welding and cutting stainless steel is another air contaminant linked with lung cancer.

Not all air contaminants affect the lungs. Once in the lung, some types of contaminants are absorbed and spread throughout the body, causing other types of health effects. For example, carbon monoxide from exhaust gases spreads

quickly via the bloodstream and can cause asphyxiation from lack of oxygen.

Lead exposure affects the nervous system, causing a wide range of symptoms, such as irritability and fatigue. Lead can also affect the kidneys, the male and female reproductive system, the blood system (anemia) and the cardiovascular system (hypertension).

Silica is known to also cause some types of kidney disease. Manganese, present in welding fumes, can affect the nervous system. Air contaminants such as sprayed materials can sometimes cause skin exposures or effects. Several substances such as toluene, xylene, manganese and lead are known to contribute to hearing loss.

How common are health effects from air contaminants? Unfortunately, national injury and illness reporting systems do not capture most of the occupational illnesses caused by air contaminants.

However, studies of construction workers show these workers typically are disproportionally affected. For example, 15.2 percent of construction workers over age 50 show evidence of lung disease, a rate almost twice as high as that for white-collar workers.[26]

In sum, air contaminants are significant because, apart from causing short-term health effects, they can cause construction workers to become sick in the years following exposures, reducing their quality and length of life.

What trades are most commonly affected?

Air contaminant hazards affect every construction trade. Masons cutting brick and block are exposed to silica. Ironworkers and painters performing bridge renovation work can be exposed to lead from decades-old coatings. Roofers can be exposed to dusts from removing old roofs and to asphalt fumes from installing new ones. Carpenters are exposed to wood dusts. Plumbers can be exposed to lead and epoxies. Insulation workers can be exposed to fiberglass and spray-foam chemicals. Construction workers performing renovation or demolition in any building built before 1980 could encounter asbestos.

In addition, workers are exposed to air contaminant hazards from the products and tools they use. Concrete workers spray form-release oils on concrete forms. Waterproofers use a variety of sealant products. Sandblasters use silica or substitutes to clean surfaces. Road and sidewalk repair workers are exposed to silica when they make sidewalk and

You should know …

Asbestos and lead

These substances were used widely in construction materials until the 1970s. Each is known to have caused many thousands of occupational illnesses and cancer deaths in the construction trades.

While not technically banned, today lead and asbestos are rarely encountered (though some imported materials may still contain them) during new construction. But this does not rule out the potential for construction worker exposures during demolition, renovation, repair and remediation tasks.

This is because these materials are still in place in numerous old buildings, structures and facilities. Comprehensive OSHA, state and provincial regulations are tailored to construction for both lead and asbestos. These regulations include provisions to prevent construction workers from inadvertently bringing contamination home to cause family exposures — an important problem documented by several studies.

[26] CPWR Chartbook, *Respiratory Diseases in the Construction Industry*, citing Dong X, Wang X, and Daw C. 2011, p 50. Chronic diseases and functional limitations among older construction workers in the United States: A 10-year follow-up study. *J. Occup. Environ. Med. 53(4)*:372-380. https://www.cpwr.com/sites/default/files/publications/CB%20page%2050.pdf.

road cuts. Many trades perform welding, which involves exposure to metal fumes and a variety of gases.

This is a very limited list: All trades have some exposure to air contaminants.

How to Look at Air Contaminant Exposures and Risks

You cannot reliably see air contaminant exposures, but you can check for these key factors that make exposures more likely to be a concern:

Highly Toxic Materials

The more toxic the material, the more significant the exposure potential is. Hazard communication information (e.g., safety data sheets) will tell you how toxic or hazardous the material is, and whether it produces vapors easily. (If it evaporates easily, inhalation is more of a concern.)

Large Amounts

Tasks using (or disturbing) larger amounts of contaminants make higher exposures more likely.

Long Durations

Tasks using (or disturbing) contaminants over longer periods of time have the potential for higher exposures.

Dispersive Equipment

Tasks using equipment that puts contaminants into the air (e.g., sprayers, saws, drills) make higher exposures more likely.

Enclosed or Confined Areas

Contaminants are more likely to build up in these locations and make higher exposures more likely.

Not Using Controls

Local exhaust ventilation (LEV) and wet methods capture or reduce contaminants at the source before workers can breathe them. General ventilation (such as large fans) dilute contaminants to lower levels. Respirators are not true controls but reduce the impact of exposures. Jobs without any controls have higher exposures.

How toxic?

Highly toxic substances …

1. Are more potent (small amounts can cause health effects)
2. Cause multiple health effects (e.g., affect lungs, liver, and kidneys versus lungs only)
3. Cause more irreversible effects (e.g., cancer versus irritation)

Do not overlook short tasks

Some construction tasks, such as setup, have little or no exposure.

However, studies show some brief construction tasks involve very high exposures, such that even a half hour or an hour can exceed limits — even if the rest of the shift has no exposure.

This is an issue for construction, where it is common to hear comments such as, "This dusty task is not a problem because it won't take very long."

What strategies can be used to control this hazard?

Plan Ahead to Identify and Reduce Potential Problems

Make sure your JSA includes air contaminant hazards so you can set up to prevent and reduce inhalation exposures. Here are some useful topics and questions to consider before starting the job. Planning resources and checklists are listed in the Additional Resources section.

Know which tasks will involve the potential for generating air contaminants.

- What tasks will involve use of chemical products?
- Will other tasks generate contaminants? Consider tasks such as hot work, demolition, disturbance, removal or remediation.

Know the hazards associated with the air contaminants for those tasks.

- For tasks using chemical products, check the SDSs (available from suppliers per OSHA Hazard Communication and other regulatory requirements). What do they say about toxic effects? What exposure controls are recommended? Do regulatory or other exposure standards exist for any of the ingredients? Do the materials create vapors during use?
- For task-generated contaminants, employers can easily obtain SDSs for welding consumables. But what about construction tasks that disturb existing in-place materials for which SDSs are not typically available? If these materials contain silica, lead or asbestos, such tasks can lead to exposures. Renovation and demolition of existing structures should be assessed ahead of time on a case-by-case basis to determine existing hazards before work begins. Industrial hygienists can assist employers with identifying in-place materials and potential exposures and developing suitable plans for safe work.

Look at the potential for exposure using the key factors mentioned earlier.

- How long is the total duration of use or disturbance or arc time (for welding)?
- How enclosed is the work area?
- How much will be used, or how much area disturbed?
- Which tools will be used? Are power tools involved? Power tools generally create higher air contaminant levels than hand tools.
- Will tools with built-in or optional controls be used? Tools that include LEV or water sprays for controlling dust creation are increasingly available.

Examine the options for preventing and reducing exposures. Evaluate and develop a plan to accompany the JSA.

- Are less toxic alternative products available?
- Can the job be performed differently to eliminate or reduce the need for chemical products or tasks that generate contaminants?
- What controls can be used? Many air contaminants are best controlled using LEV or wet methods. Many construction tools now come with these types of controls built in or available as an option. For example, vacuum-shrouded exhaust systems are available equipped with high-efficiency filters called HEPA[27] filters that capture the dusts at the source. Local exhaust and wet methods also help reduce exposures to bystanders (e.g., co-workers or other trades working close by), which is a common problem in construction. Wet cutting not only controls hazardous dusts but also has the additional advantage of cooling the tool blade, which makes it last longer. In some cases, general ventilation (e.g., fans or, when outdoors, staying upwind of the work) can help. Good housekeeping is also important for controlling exposures. Hazardous dusts that accumulate on surfaces can be kicked up or blown up into the air to contaminate the air. Hazardous dusts can be captured by a HEPA vacuum cleaner. Avoid dry sweeping. And remember when using a HEPA vac, as with your home vacuum, to always use care in emptying contents to minimize unnecessary dust exposures.
- Are respirators appropriate? This type of PPE should be used only if other types of engineering controls are insufficient or not possible. Respirator use requires a program to ensure the correct types of filters are selected, the respirators fit the employees, the employees are trained in how to wear respirators and the employees are medically fit to wear the respirators. Industrial hygienists can assist employers with developing such programs and monitoring the air to ensure the respirators have a sufficient protection factor.

What is hot work?

Hot work is welding, brazing, cutting or combustion, during which heat can create air contaminants, combustion products or decomposition products.

[27] HEPA vacuums use a high-efficiency particulate air filter, which can filter out 99.9 percent of small particles.

- Will highly toxic materials be used? If so, the stakes are higher, and more advanced planning is needed. In such a case, consulting with an industrial hygienist can be helpful, especially if you believe the task will involve risk factors such as significant amounts of materials to be used, confined spaces or a long duration of exposure.

Implement and Check on Control Practices

Use the JSA and plan from the above steps to raise awareness among supervisors and workers and to demonstrate the proper work procedures and controls for reducing air contaminant exposures.

Check on the job to ensure the recommended controls are being used. Changes in tasks, materials, equipment and environmental conditions can affect exposure potential. Checking on controls and PPE is important to make sure they are working correctly. Proper maintenance is necessary for the controls and PPE to be effective. Some controls come with simple alerts to tell you when filters should be changed or are clogged, and some respirator cartridges have an end-of-life indicator to help users determine when to change their cartridges.

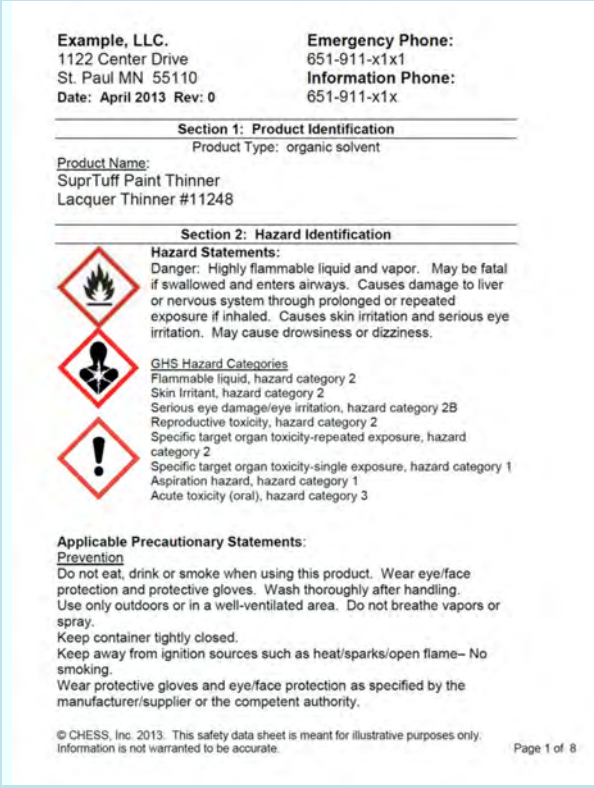
Regulations and Guidance

United States

- The OSHA "Hazard Communication" standard (29 CFR 1926.59) requires chemical manufacturers and suppliers to evaluate the hazards of the ingredients in their products and to provide that information, along with handling precautions, to their customers — including construction employers — via SDSs. Employers should then use that information to train potentially exposed workers about the hazards of the materials and to take precautions during use.
- Two types of U.S. standards address air contaminants. The first type covers specific air contaminants, such as asbestos (29 CFR 1926.1101), lead (29 CFR 1926.62), respirable crystalline silica (29 CFR 1926.1153), chromium VI (hexavalent chromium; 29 CFR 1926.1126), cadmium

What are safety data sheets (SDSs)?

Suppliers are required to provide these sheets to employers to communicate key information about chemical products.



Example, LLC.
1122 Center Drive
St. Paul MN 55110
Date: April 2013 Rev: 0

Emergency Phone:
651-911-x1x1
Information Phone:
651-911-x1x

Section 1: Product Identification
Product Type: organic solvent

Product Name:
SuprTuff Paint Thinner
Lacquer Thinner #11248

Section 2: Hazard Identification

Hazard Statements:
Danger: Highly flammable liquid and vapor. May be fatal if swallowed and enters airways. Causes damage to liver or nervous system through prolonged or repeated exposure if inhaled. Causes skin irritation and serious eye irritation. May cause drowsiness or dizziness.

GHS Hazard Categories
Flammable liquid, hazard category 2
Skin Irritant, hazard category 2
Serious eye damage/eye irritation, hazard category 2B
Reproductive toxicity, hazard category 2
Specific target organ toxicity-repeated exposure, hazard category 2
Specific target organ toxicity-single exposure, hazard category 1
Aspiration hazard, hazard category 1
Acute toxicity (oral), hazard category 3

Applicable Precautionary Statements:
Prevention
Do not eat, drink or smoke when using this product. Wear eye/face protection and protective gloves. Wash thoroughly after handling.
Use only outdoors or in a well-ventilated area. Do not breathe vapors or spray.
Keep container tightly closed.
Keep away from ignition sources such as heat/sparks/open flame– No smoking.
Wear protective gloves and eye/face protection as specified by the manufacturer/supplier or the competent authority.

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This is an example of the first page of a typical safety data sheet. SDSs include 16 information sections:

1. Identification
2. Hazard identification
3. Ingredients
4. First aid measures
5. Firefighting measures
6. Accidental release
7. Handling and storage
8. Exposure controls/PPE
9. Physical and chemical properties
10. Stability and reactivity
11. Toxicological information
12. Ecological information
13. Disposal considerations
14. Transport information
15. Regulatory information
16. Other information

Source: Janet L. Keyes.

(29 CFR 1926.1127) and formaldehyde (29 CFR 1926.1148), which have comprehensive construction-tailored requirements. These standards include specific requirements for training, air sampling, recordkeeping and even medical testing for exposed employees.

The second type of standards for other construction air contaminants are more basic PEL standards found at 29 CFR 1926.55. These date from 1970, though some states have adopted more recent ones. These PELs are now more than 45 years old and cannot be considered sufficiently protective. Also, there are many substances for which OSHA does not have workplace exposure limits. In most cases, it is more appropriate to rely on the more protective current exposure limits issued by groups such as NIOSH, ACGIH, states and provinces, or suppliers to evaluate exposures. OSHA has created a helpful table to address these issues and provide alternatives at https://www.osha.gov/dsg/annotated-pels/.

- In addition to these standards, several other OSHA standards relate directly to air contaminants:
  - The "Respiratory Protection" standard applicable to construction work (29 CFR 1926.103), identical to the general industry standard (29 CFR 1910.134), describes and governs the type of program needed to support respirator use.
  - The "Confined Spaces in Construction" standard, Subpart AA (29 CFR 1926.1200-1213) governs construction work in confined work areas such as boilers, manholes, tanks, storm drains, vaults and similar hazardous locations. Confined spaces require their own types of specialized "entry" air sampling, which checks for sufficient oxygen and other potential hazards prior to entry.
  - The "Ventilation" standard (29 CFR 1926.57) provides broad requirements to use ventilation to control air contaminants below exposure limits. The more specific "Ventilation and Protection in Welding, Cutting, and Heating" standard, 29 CFR 1926.353, addresses the use of controls with a focus on base or filler materials containing zinc, lead, cadmium or chromium. Related requirements in 29 CFR 1926.354 address the removal of toxic preservative coatings prior to welding to prevent these from producing air contaminants.
  - The "Process Safety Management of Highly Hazardous Chemicals" standard (29 CFR 1926.64) addresses work at sites such as oil refineries and chemical facilities.
  - The "Hazardous Waste Operations and Emergency Response" standard (29 CFR 1926.65) addresses work with hazardous substances — including hazardous waste — in certain types of operations.

Many types of guidance materials are available. Fact sheets on specific chemicals are available from OSHA, NIOSH and many states. A voluntary ANSI consensus standard, A10.49, "Control of Chemical Health Hazards in

You should know …

Many OSHA PELS are outdated

"OSHA recognizes that many of its permissible exposure limits (PELs) are outdated and inadequate for ensuring protection of worker health.

"OSHA recommends that employers consider using the alternative occupational exposure limits because the Agency believes that exposures above some of these alternative occupational exposure limits may be hazardous to workers, even when the exposure levels are in compliance with the relevant PELs."

Source: https://www.osha.gov/dsg/annotated-pels/.

In other words, exposures could be *below* an outdated OSHA PEL but be *above* another, more up-to-date alternative exposure limit —meaning that health effects could occur.

Alternative OELS (such as the RELs, TLVs and other international OELs) should play a major role in judging exposures.

Construction and Demolition Operations," provides a contractor-friendly approach for performing prejob health hazard analyses. See the Additional Resources section for a list and links.

Canada

A Canada-wide system called Workplace Hazardous Materials Information System (WHMIS) is aligned with the OSHA "Hazard Communication" standard and provides the same type of information on chemical product hazards and precautions.

All jurisdictions in Canada have additional requirements for the assessment, handling and use of chemicals in the workplace. Development of legal exposure limits is regulated at the provincial level. Most of the provinces have adopted ACGIH TLVs, supplemented by internally developed limits. In most of the provinces, the exposure limits are periodically updated to bring the legal standards up to date. Similarly, provincial-level requirements address subjects such as respirators, confined spaces, process safety and hazardous wastes.

Numerous guidance materials about chemicals, ventilation and respirators are available. See the Additional Resources section for a list and links.

Good Practice

Construction employers should use their hazard communication information and JSAs to focus efforts on hazardous chemicals and tasks where exposure is most likely. Because so many legal exposure limits are out of date, employers should always ask for (or consult) more recent exposure limits to guide their good practice efforts.

You should know …

Occupational exposure limits (OELs) for air contaminants

Industrial hygienists have developed various types of air concentration limits to guide efforts to control exposures. Here are the most common:

Some air contaminants can cause damage from brief but high exposures.

Immediately dangerous to life or health (IDLH) is the exposure level likely to cause death or permanent health effects or prevent escape.

Short-term exposure limits (listed as STEL) call for exposures not to exceed the listed concentration in a 15-minute time period anytime. Some STELs allow up to four peaks per day with a minimal interval of one hour in between.

Ceiling limits (listed as C or STEL-C) call for exposures not to exceed that amount **at any time**.

For other air contaminants, occasional high levels can be tolerated as long as there are also compensating low-level periods. Exposure limits for these materials average out these differences over an eight-hour shift using a **time-weighted average (TWA)**.

Industrial hygienists evaluate exposures by collecting air samples and comparing findings to existing OEL standards. These are the most common OELs:

PELs – OSHA-enforceable standards are called **permissible exposure limits**.

RELs – NIOSH nonregulatory OELs are called **recommended exposure limits**.

TLVs – **Threshold limit values** are OEL guidelines published by the American Conference of Governmental Industrial Hygienists (ACGIH), a professional association.

Other – Many states, provinces and chemical manufacturers have developed their own recommended or required exposure limits.

Exposure concentrations are listed as either PPM (parts of contaminant per million parts of air) or mg/m3 (milligrams of contaminant per cubic meter of air). Employees typically breathe about 10 to 15 cubic meters of air in a given shift depending on exertion.

How can trade groups help?

The many trade-specific employer and employee organizations in construction can work together to target the most common air contaminant hazards and exposures in their trade. These trade groups can be particularly effective at sharing information and resources for effective control measures. Dissemination of specific guidance and training materials tailored to the trade can help address this Focus Four hazard.

How can an industrial hygienist help?

Industrial hygienists can assist employers with identifying tasks most likely to cause overexposures. They can provide expert advice on the hazards posed by chemical products and can recommend alternative options. They can test bulk samples of unknown materials to identify their content and then recommend specific protective measures prior to disturbance. They can perform tests to monitor the levels of contaminants in the air and compare them with exposure standards.

Industrial hygienists can provide specific recommendations on better procedures, materials and controls to reduce exposures. They can help set up employer programs and train supervisors on how to perform better JSAs to address air contaminant risks. Industrial hygienists can also provide oversight to ensure effective programs.

Note these additional points about working with an industrial hygienist on air contaminants:

- You are the expert on the type of work you do. Use your knowledge to have the industrial hygienist visit on days when your workers are performing tasks using high-hazard materials and when there is a high likelihood of exposure. That will provide the most value from the visit.
- Do not focus only on compliance with eight-hour exposure limits. Focus also on high-exposure tasks and peak short-term exposures. Given that many OSHA PELs are out of date, do not seek evaluations of compliance with only those limits. Instead, ask that more current exposure guidelines be included, since they are better predictors of whether employees might be affected by the observed air contaminant exposures.

You should know …

Selection and care of respirators

Respirators can play an important role in protecting employees from air contaminant exposures. However, they provide very little protection if not correctly selected and used.

Here are few important considerations:

Match the correct filter to the contaminant. For air-purifying respirators, it is important to have information about what substance to protect against. For example, dust filters do not filter out solvent vapors. A special combination filter is needed if both substances are present.

Know when atmosphere-supplying respirators are needed. Air-purifying respirators cannot be used for some substances (e.g., methylene chloride), so masks that provide clean air are needed in these cases.

Match the correct respirator to the anticipated exposure level. Respirator selection needs to take into consideration the likely exposure level. This is because even a properly worn respirator will allow some inward leakage due to imperfections in how it seals the face. The assigned protection factor (APF) provides this information for respirators. For example, a basic two-strap dust mask has an APF of 10, meaning that if worn and fitted correctly, it reduces the exposure to the wearer by a factor of 10. This means there is a 10 percent leakage rate: The wearer will likely get 10 percent of the contamination level and would be overexposed if the air contaminant level exceeded 10 times over the OEL. A full-face mask with a higher APF would be needed for such exposures.

Use a respirator program to ensure proper procedures are followed. Training, fit, cleaning and maintenance are examples of topics that should be addressed. See the end of this section for additional resources.

Takeaway Messages

1. Occupational illnesses from air contaminants are preventable. Risks can be reduced significantly by proper planning and use of controls. Using safety approaches such as pre-job planning and competent persons can effectively reduce air contaminant creation in the first place.
2. Many construction employers view air contaminants as problems solved by respirator use. Respirators have their place, but they should be the last option in most cases. Respirators will not protect well if not supported by a disciplined respirator program to ensure the respirators are correctly chosen, used and maintained. When performing JSAs, the best approach is to start with the most reliable and effective options available and work down:

   Most effective: Control at the source

   a. Remove the hazardous product from the task (elimination).
   b. Use a less toxic substitute.
   c. Change the task itself or how long it takes, or isolate the source from the worker.

   Effective: Control along the path from source to worker

   a. Use LEV to capture emissions.
   b. Use wet methods to suppress dust.
   c. Use general ventilation to dilute contamination.
   d. Use good housekeeping (e.g., HEPA vacuum instead of sweeping).

   Least effective: Control at the worker level

   a. Develop work procedures to reduce variations that create emissions.
   b. Provide PPE and training.
   c. Provide hygiene facilities.
   d. Provide supervision.
3. Dusts cause major air contaminant problems on many construction jobs. Dust is more than just a nuisance: It is a hazard when it contains silica or other toxic materials. Much dust is created from power tools used for cutting, grinding, drilling and similar work. Dust can typically be reduced by 90 percent by using commercially available equipment, such as water sprays and tools with vacuum attachments. When you purchase new tools and equipment, you have an excellent opportunity to improve your workers' health by choosing equipment that includes controls. Retrofit kits are also available for many older tools. Ask for controls when you rent tools as well.
4. Dusts and contamination created by construction contractors have been known to cause problems with nearby trades, complaints from the public, environmental violations and customer complaints. The ability to perform work with minimal creation of dust and air contaminants is increasingly marketable, especially for work in schools, hospitals, labs and occupied buildings.
5. Here's an analogy to consider: If you needed a medical procedure and you were given two options — one procedure that incorporated the latest findings and one that had not been updated in 50 years — which one would you choose? Similarly, would you purposely choose to restrict your choice of medicines to those developed before 1970? Keep these types of questions in mind when relying on OSHA's PELs. Does the annotated PEL table indicate there is a more up-to-date and protective exposure limit available for a particular PEL? If so, take that into consideration. Compliance is not much consolation in cases in which employees could still suffer ill effects at the PEL. The better approach is to always rely on the most current and best available exposure guidance when evaluating and controlling air contaminant exposures.

Additional Resources

OSHA has a Chemical Hazards and Toxic Substances web page available at https://www.osha.gov/SLTC/hazardoustoxicsubstances/index.html. The air contaminant standard for Construction (CFR 1926.55) is available at https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=Standards&p_id=10628. An Occupational Chemical Database with information on many

different chemicals is available at https://www.osha.gov/chemicaldata/index.html. The OSHA annotated tables are provided at https://www.osha.gov/dsg/annotated-pels/index.html. There is also an "OSHA Toolkit: Transitioning to Safer Chemicals" that provides guidance on how to use less toxic materials. Numerous other resources are available for specific contaminants such as lead, asbestos and carbon monoxide. See this OSHA Prevention Video for an example.

NIOSH has numerous construction-related air contaminant resources: https://www.cdc.gov/niosh/construction/default.html. The "NIOSH Pocket Guide to Chemical Hazards" provides key information on many air contaminants. It is also available as an app at https://www.cdc.gov/niosh/npg/mobilepocketguide.html.

Construction health hazard training materials developed by the Construction Safety Council are available at https://www.osha.gov/dte/grant_materials/fy09/sh-19495-09.html.

ANSI/ASSE Standard A10.49- 2015, "Control of Chemical Health Hazards in Construction and Demolition Operations," provides a helpful template for how construction employers can use JSAs to evaluate and control construction air contaminants. An article by Laborers' Health & Safety Fund of North America describing the approach is available at https://www.lhsfna.org/index.cfm/lifelines/february-2015/a-new-approach-to-chemical-health-hazards/, and the standard can be ordered at https://store.assp.org.

CPWR- The Center for Construction Research and Training has numerous resources on air contaminants at its eLCOSH website, http://www.elcosh.org/en/index.php?menu=hazards, and in its Construction Solutions Database, http://www.cpwrconstructionsolutions.org/. There is also a silica-specific site developed to assist contractors with evaluating and controlling silica dust exposures. See https://plan.silica-safe.org/.

The Canadian Centre for Occupational Health and Safety chemical topic page, http://www.ccohs.ca/topics/hazards/chemical/, provides information on specific air contaminants

The Canadian site http://ccinfoweb2.ccohs.ca/legislation/documents/notes/oshleg/leg_tlv.htm includes links to provincial laws governing air contaminant exposures.

Many of the Canadian provinces have resources that include information on air contaminants. For example, Quebec has a safety and health research institute with resources. See http://www.irsst.qc.ca/en/ohs-research/research-priorities/chemical-biological-hazard-prevention.

British Columbia has a variety of topics available at https://www.worksafebc.com/en/health-safety, including a video that helps describe how silica exposure affects the body at https://www.worksafebc.com/en/resources/health-safety/videos/silica-exposure?lang=en.

FOCUS FOUR FOR HEALTH: HIGH TEMPERATURES

What is the hazard?

North American summers are hot and heat waves are common. *The past 16 years rank among the top 17 warmest on record.*[28] High temperatures affect construction because much of the work is performed either outdoors or in unventilated, partially constructed buildings.

Very hot temperatures interfere with the body's ability to regulate its core temperature, which averages 98.6 degrees Fahrenheit (37 degrees Celsius). If the body cannot dissipate excess heat, serious damage and even death can occur. This can happen to anyone, even the young and fit.

Contributing factors common to construction — such as strenuous workloads or the additional heat load caused by personal protective equipment such as gloves, protective suits or respirators — can increase the possibility of heat-related problems, even at temperatures many people would find comfortable.

Everyone knows when it is hot. But employers and workers may not always recognize symptoms from high temperature exposures. The ability to think clearly is affected, so affected workers may not speak up. Also, as a result of heat-related symptoms, workers could be at higher risk for other safety hazards such as trips and falls.

How severe are the health hazards and how common are they?

Heat-related hazards range from less serious effects, such as heat rash or fatigue, to life-threatening effects, such as heat stroke. Every year in the United States, thousands of workers become sick from heat exposure, and on average, about 30 of these workers die.

In hot working conditions, the body tries to regulate its normal temperature by transferring heat from the body core to the skin, where cooling can occur via perspiration. The body can acclimatize to high temperatures after five to seven days of working in hot conditions. Once acclimatized, the body is more efficient in accommodating the heat, but this adjustment can be lost after only four or five days of cooler conditions. The body's ability to cool itself can be overwhelmed by high temperatures, or from the influence of contributing factors such as workload, humidity, heavier clothing, dehydration or pre-existing medical conditions.

Unlike some of the delayed effects common with other Focus Four for Health hazards, these heat stress effects tend to occur during or shortly after exposure. The following are the most common heat disorders that can occur, along with their symptoms and first aid information:

Heat Stroke

This is the most serious heat-related illness. It occurs when the body is unable to control its temperature. Body temperature rises rapidly (and can reach 106 degrees Fahrenheit (41 degrees Celsius) or higher within 10 to 15 minutes), sweating fails and the body is unable to cool down. *This is a medical emergency that can cause death or permanent disability if not treated quickly.* Even when heat stroke is treated, the death rate may be as high as 33 percent.

Symptoms

- Very high body temperature
- Red, hot, dry skin is most common, but profuse sweating can also occur
- Confusion, slurred speech
- Fainting or loss of consciousness
- Seizures or convulsions

First Aid

- Call 911 for emergency medical care and make it clear you suspect heat stroke.
- Move the worker to a shaded, cool area and remove his or her outer clothing.

[28] Dahlman L. Aug. 1, 2018. Climate Change: Global Temperature. https://www.climate.gov/news-features/understanding-climate/climate-change-global-temperature.

- Cool the worker quickly and aggressively with a cold water or ice bath if possible. Wet the skin, place cold, wet cloths on the skin (particularly on the head, neck, armpits and groin) or soak clothing with cool water.
- Circulate air around the worker to speed cooling.
- Stay with the worker until emergency medical services arrive.

Heat Exhaustion

This occurs when the body has lost too much water and salt, usually through excessive sweating. Older workers and those with high blood pressure may be more prone to experience heat exhaustion. Heat exhaustion, if untreated, can progress into heat stroke.

Symptoms

- Heavy sweating
- Elevated body temperature
- Headache
- Nausea, vomiting
- Dizziness
- Weakness
- Irritability
- Thirst
- Decreased urine output

First Aid

- Take the worker to a clinic or emergency room for medical evaluation and treatment.
- If medical care is unavailable, call 911.
- Remove the worker from the hot area and give him or her liquids to drink; encourage frequent sips of cool water.
- Remove unnecessary clothing, including shoes and socks.
- Cool the worker with cold compresses or have the worker wash his or her head, face and neck with cold water.
- Make sure someone stays with the worker until help arrives.

You should know …

These factors aggravate heat conditions

- Working in direct sunlight
- Protective clothing, especially semipermeable or impermeable types
- Respirator use
- Hot work such as welding or working around steam
- Carrying additional weight from tools and protective equipment

Heat Syncope

This is an episode of fainting or dizziness that most commonly occurs after prolonged standing or sudden rising from a sitting or lying position. It does not involve an increase in body temperature. Factors that may contribute to heat syncope include dehydration and lack of acclimatization.

Symptoms

- Fainting (short duration)
- Dizziness
- Light-headedness during prolonged standing or suddenly rising from a sitting or lying position

You should know …

High temperatures can contribute to injuries

- Sweaty palms can lose grip.
- Fogged safety glasses can cause trips.
- Dizziness can cause falls.
- Hot surfaces can lead to burns.

First Aid

- Have the worker sit or lie down in a cool place.
- Have the worker slowly drink water, clear juice or a sports drink.

Heat Cramps

This can occur after heavy sweating during strenuous activity. Low salt levels in muscles cause painful cramps, mainly in the arms, hands, legs and feet. Note that heat cramps may also be a symptom of heat exhaustion.

Symptoms

- Muscle cramps, pain or spasms in the abdomen, arms or legs

First Aid

- Have the worker drink water and eat a snack and/or drink a carbohydrate-electrolyte replacement liquid (e.g., sports drink) every 15 to 20 minutes.
- Avoid salt tablets.
- Get medical help if the worker has heart problems or is on a low-sodium diet, or if cramps do not subside within one hour.

Heat Rash

This is a skin irritation caused by excessive sweating during hot, humid weather.

Symptoms

- A red cluster of pimples or small blisters
- Prickling sensations in some cases
- Usually appears on neck, upper chest, groin and elbow creases — areas where sweat cannot evaporate

First aid

- Keep the rash area dry.
- Powder may be applied to increase comfort.
- Ointments and creams should not be used.
- When possible, a cooler, less humid work environment is the best treatment.

You should know …

Acclimatization is an important consideration

OSHA investigated 20 heat illness cases in 2012 to 2013 that involved 13 deaths.

Of those 13 deaths, 9 occurred on the first three days of the job.

Of those 9 deaths, 4 occurred on the first day of the job.

Looking Out for Signs and Symptoms

Construction workers and supervisors work hard and tend not to complain. Nobody wants to be the person who could not keep up with the work. Do not rely on workers voluntarily stopping work to report they are being affected by the heat. Instead, make sure workers and supervisors receive training to recognize the symptoms of heat illnesses and know how to address those symptoms. Encourage crew members to look out for one another.

In addition to the symptoms described above, these signs and behaviors may indicate a worker is struggling to deal with the heat:

- Decreased productivity
- Awkward postures (to compensate for fatigue)
- More frequent breaks
- Hand/limb shaking
- Increased absenteeism

Many factors influence how a given worker responds to the heat. These include age, weight, degree of fitness, medication use (e.g., diuretics, blood pressure medications, antihistamines, anticholinergic medications), or use of alcohol, drug use and caffeine. But keep in mind that susceptibility to heat is not just about personal health factors: If one individual is being affected, consider it likely that

others could be affected as well. Dealing with heat effectively takes good site leadership.

What trades are most commonly affected?

High-temperature hazards affect every construction trade. Most construction begins with outdoor work that involves direct exposure to the prevailing temperatures. For indoor building construction work, high temperatures can be experienced because the HVAC system typically is not functional until late in the building completion process.

Specialized construction work in locations such as refineries, power plants or factory settings can include hot work or work around heat sources such as furnaces or steam lines. Many tasks require use of protective gear; some tasks, such as asbestos abatement and hazardous waste work, require the use of semipermeable or impermeable clothing and respirators, which contribute to heat stress conditions for workers.

Finally, the nature of construction projects means new employees are commonly arriving on site as the job progresses. New and temporary workers are more vulnerable to heat conditions until they acclimatize to the heat and work setting.

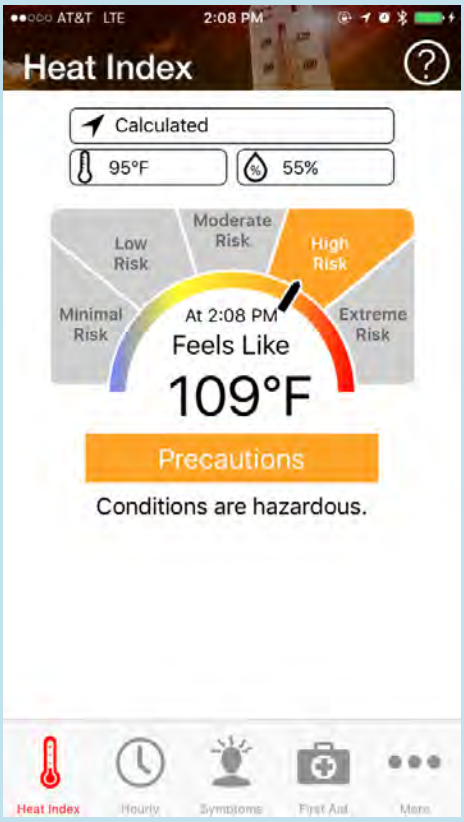
How to Look at High-Temperature Exposures and Risks

The potential for upcoming high-temperature hazards is easy to find out about. Weather forecasts are available from TV, radio and the internet. Contractors and workers can easily get temperature estimates for the current day, the following day and the week ahead to gain awareness about upcoming high temperatures.

The heat index, or "feels like" temperature, is also routinely provided. The heat index is a measure of how hot it feels when relative humidity is factored in with the actual air temperature. The National Weather Service provides heat alerts, which are based on the heat index and are announced on TV and radio. See OSHA's Using the Heat Index: A Guide for Employers.

Helpful apps are also available. The OSHA-NIOSH Heat Safety Tool is an app that allows supervisors and workers to calculate the heat index for their worksite and, based on the heat index, displays a risk level to outdoor workers. It also provides additional information and reminders about how to prevent heat stress. This information can be combined with a JSA to give contractors a good indication of the need for high-temperature precautions.

OSHA-NIOSH Heat Safety Tool app



Available at https://www.osha.gov/heat/index.html.

What strategies can be used to control this hazard?

Plan Ahead to Identify and Reduce Potential Problems

Make sure your JSA includes high-temperature hazards so you can set up the job to prevent heat stress problems. Consider these useful topics and questions before starting the job. Planning resources and checklists are listed in the

Additional Resources section.

- Know the upcoming weather forecast.
  - Are high heat index days forecast for the week ahead? If so, you will need to implement your heat illness prevention program.
- Consider the stage or season of work to account for acclimatization.
- Is this the project just beginning? Or is the work being performed at the beginning of the hot season? Work in late spring or early summer can still pose a risk, especially when temperatures get hot for the first time.
- Consider the worker:
  - Will new workers or temporary workers be coming on the site to start work?
  - Or are workers transitioning from inside work to outside work?

In each case, you should factor in that workers may not be acclimatized to the heat.

- Consider the work area characteristics:
  - Will work be performed out in the sun, with little shade?
  - Will work involve confined areas (e.g., elevator or grease pits) where ventilation is minimal? Will any work areas be below grade, where air movement is minimal?
  - Will work involve heat sources, such as steam or radiant heat or welding? Will work include surfaces, such as metal decking, that heat from the sun?

In each case, you should plan for additional heat loads.

- Consider the physical workload:
  - How strenuous is the work? Does it involve heavy manual work, such as lifting?
- Consider the work gear needed:
  - Will the tasks require PPE, such as gloves or respirators?
  - Will workers need to wear other gear, such as toolbelts or safety harnesses?

You should know …

Full sun matters

The National Oceanic and Atmospheric Administration (NOAA) uses the heat index as the basis for its extreme heat alerts. The heat index was devised for shady, light wind conditions. However, working in full sunlight can increase heat index values by 15 degrees Fahrenheit (9 degrees Celsius).

Keep this in mind and plan additional precautions for working in these conditions.

Providing shade is a simple but important precaution.

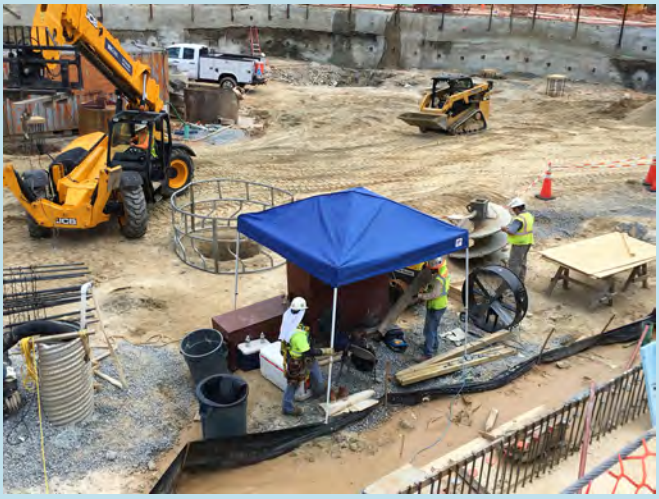


Photo: Lisa Capicik.

Take all of these into consideration when planning the work.

Implement and Check on Control Practices

The goal is to tailor your heat illness prevention program to match the likely risk level predicted by the heat index forecast for the work period. There are four targeted bands, or levels, using current OSHA guidance: caution, extreme caution, danger and extreme danger.

Step 1: Obtain the heat index forecast. This can be obtained from the OSHA app or from local weather information. NOAA's National Weather Service heat index provides the four starting risk levels for the forecast.

Step 2: Adjust risk levels to account for construction risk factors.

Full sun factors

- 100 percent of work in full sun
  - Add 15 degrees Fahrenheit to heat index
- 75 percent of work in full sun
  - Add 12 degrees Fahrenheit to heat index
- 50 percent of work in full sun
  - Add 8 degrees Fahrenheit to heat index
- 25 percent of work in full sun
  - Add 4 degrees Fahrenheit to heat index

Other work factors

In general, you should adjust to the next-higher risk level or otherwise add specific precautions when any of the following three types of construction factors apply.

Work area factors

1. Confined area or below-grade work
2. Hot work or work near steam sources
3. Surfaces that heat in the sun, such as metal decking or asphalt

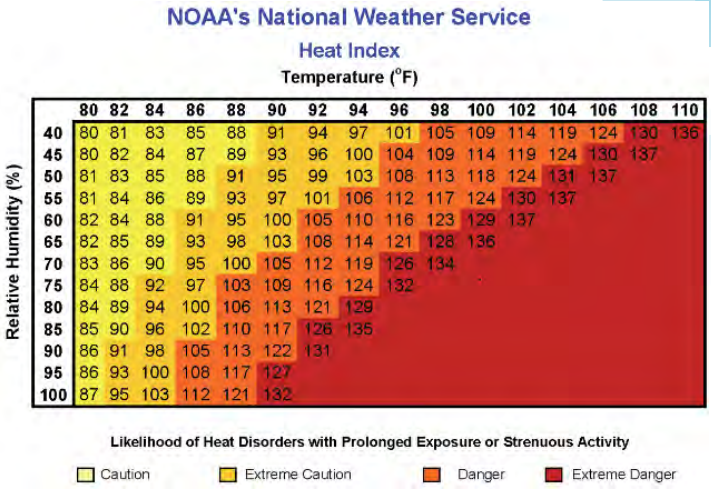
Workload factors

1. Strenuous task work[29]
2. Using heavy or nonbreathable protective clothing
3. Using respirators

Workforce factors

New or returning workers who are not acclimatized (see discussion below)

For additional guidance, see https://www.osha.gov/SLTC/heatillness/heat_index/index.html.



Step 3: Determine the risk level and tailor appropriate protective measure program elements.

Additional and more rigorous measures are used at higher risk levels. OSHA provides guidance on program elements for employers at https://www.osha.gov/SLTC/heatillness/heat_index/pdfs/protective_measures.pdf. The following are some considerations for tailoring heat illness prevention program elements:

Adequate Water for Hydration

Heat causes significant loss of water through sweating. Employers need to provide ample supplies of cool (50 to 60 degrees Fahrenheit, or 10 to 15 degrees Celsius) water close to the work area and make sure workers know the location. Workers need to stay hydrated by drinking small amounts of water throughout the day. Drinking one cup every 20 minutes is more beneficial than drinking a large amount a couple of times a day.

When work requires exertion in a hot environment for a prolonged period (more than two hours), drinks that contain carbohydrates and electrolytes (sports drinks such as Gatorade®) should be used in place of water to replace the electrolytes lost from sweating and to avoid lowering the sodium level in the blood, a condition known as hyponatremia, from excessive consumption of plain water.

[29] OSHA. Estimating Workloads. https://www.osha.gov/SLTC/heatillness/heat_index/work_rates_loads.html.

Worker training about hydration (see chart on urine color) can include a simple urine color check to provide feedback for workers on their level of hydration. In general, if the urine is too yellow, the worker knows he or she is becoming dehydrated. A urine color check may not be easy to perform in a portable toilet, but employees can complete this check when using traditional facilities on- or offsite.

Proper hydration in hot conditions means drinking a lot of water. Charts or posters such as "Are You Properly Hydrated?" can help communicate levels of hydration to workers and supervisors.

Shade and Rest Break Areas

Providing a designated rest break area is important. At the very least, the rest break area should be shaded. Another option is to use a cooled area for rest breaks (such as an air-conditioned trailer) or cool mist stations.

Providing shade for work areas is also a simple but important measure. Consider providing a shade canopy for work stations, such as for masonry saws or similar operations.

Engineering Controls and PPE

As with the other Focus Four for Health hazards, engineering controls can play an important role in reducing hazards and exposures. Using power-assist equipment and tools can reduce the load or time needed for strenuous manual handling tasks.

Insulation and heat shields can be used to reduce the heat contribution of nearby surfaces that would otherwise exceed 95 degrees Fahrenheit (35 degrees Celsius), adding to the worker's heat load.

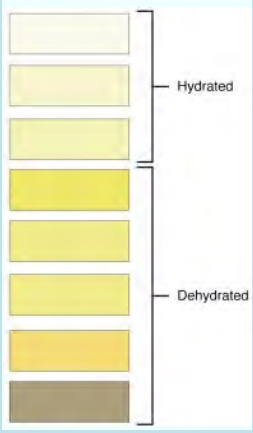
Ventilation can be used to dilute hot air with cooler air drawn in from outside (if the temperature is cooler outside). Air cooling can also be used. It differs from ventilation because it reduces the temperature of the air by removing heat (and sometimes humidity) from the air. Local air cooling using a portable blower with a built-in air chiller can be effective in reducing air temperature in specific areas.

Basic fans are a simple option, but it is important to understand how they work. Moving air directed on a worker can reduce the body temperature — *provided that the temperature of the air is less than the worker's skin temperature.* If the temperature is higher than 95 degrees Fahrenheit (35 degrees

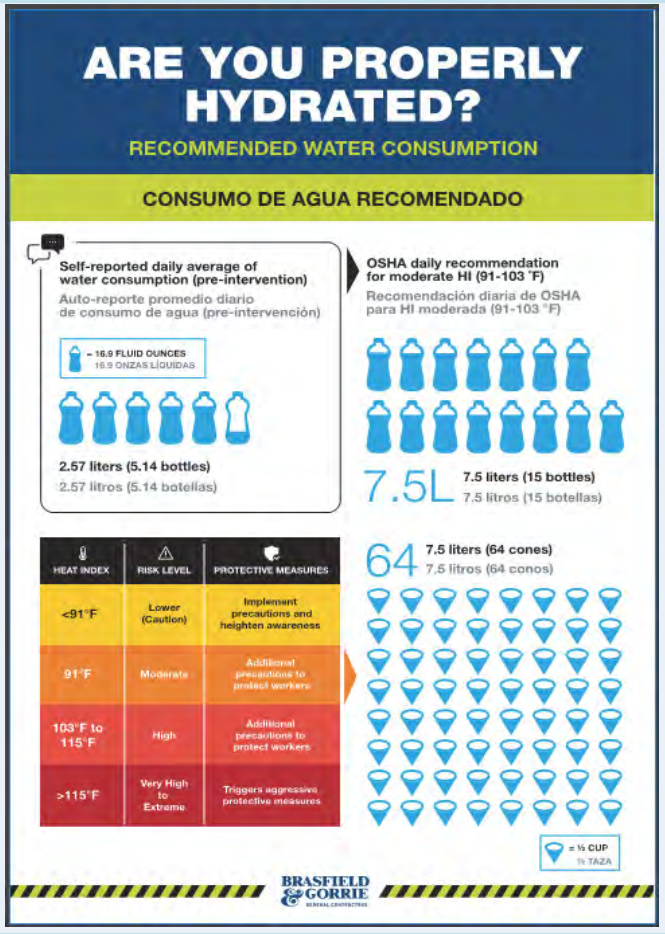
OSHA-NIOSH Heat Safety Tool app plan elements

Plan Element	Heat Index Risk Level			
	Lower (Caution)	Moderate	High	Very High/Extreme
Supplies (ensuring adequate water, provisions for rest areas, and other supplies)	✓	✓	✓	✓
Emergency planning and response (preparing supervisors and crews for emergencies)	✓	✓	✓	✓
Worker acclimatization (gradually increasing workloads; allowing more frequent breaks as workers adapt to the heat)	✓	✓	✓	✓
Modified work schedules (establishing systems to enable adjustments to work schedules)		✓	✓	✓
Training (preparing workers to recognize heat-related illness and preventive measures)	✓	✓	✓	✓
Physiological, visual, and verbal monitoring (using direct observation and physiological monitoring to check for signs of heat-related illness)		✓	✓	✓

Urine color and hydration



Hydration — How much is needed?



Source: Lisa Capicik, with thanks to Brasfield & Gorrie.

Celsius), the hot air passing over the skin can make the worker hotter. Fans have no effect on the body temperature of workers wearing vapor-barrier clothing.

Personal cooling options are also available, such as cooling vests that use pockets to hold cold packs. These are especially helpful when other types of heavy PPE are being used. Simpler measures include water-dampened clothing and clothing that reflects light and heat.

Emergency Planning and Response

Heat stroke and heat stress can kill, so emergency planning is important. If no medical services (e.g., emergency medical services, clinic, hospital) are available within three to four minutes, then appropriately trained personnel (with a valid certificate in first aid training from the American Red Cross or equivalent training) and adequate medical supplies are needed on-site.

Worker Acclimatization

New workers or workers returning to the job after being away are especially vulnerable to hot conditions. Their bodies need time to adjust. Body temperature, pulse rate and general discomfort will be higher on the first day of work in a hot environment. These responses will gradually decrease daily. OSHA and NIOSH have developed scheduling guidance to help prevent heat illnesses. The schedules can be used for the first week of new or returning work whenever it involves temperatures above 90 degrees Fahrenheit (or above 70 degrees Fahrenheit if the work involves wearing impermeable or semi-impermeable clothing).

For example, new workers and those returning from a prolonged absence should begin with 20 percent of the workload on the first day, increasing incrementally by no more than 20 percent each subsequent day. The guidance is summarized in the "Acclimatization scheduling guidance" sidebar.

Acclimatization scheduling guidance

Day	Percent Exposure	
	New Worker	Returning Worker
1	20	50
2	40	60
3	60	80
4	80	100
5	100	

Source: Adapted from NIOSH (2016).

Some additional flexibility is recommended. Keep in mind that the time required for nonphysically fit individuals to acclimatize is about 50 percent greater than for the physically fit. Also, full acclimatization may take up to two weeks for some individuals due to certain medications or medical conditions.

Finally, acclimatization does not mean that workers can cope with all temperatures. A heat wave with higher than normal temperatures can still affect workers acclimatized to lower but still-hot temperatures.

Modified Work Schedules

In addition to acclimatization, work scheduling is a valuable tool with many options. Strenuous work can be scheduled for earlier in the day when temperatures are cooler. Extra personnel can be added to divide strenuous tasks. Strenuous tasks can also be alternated with lighter tasks to minimize overheating. Scheduling can be used to formalize break periods to ensure heat rest breaks are taken.

The number of breaks should be informed by the heat stress index. For example, strenuous work might be limited to 45 minutes of every hour for high-heat-index work and might be limited further to 15 minutes of every hour for very-high-heat-index work.

Worker Training

As with other health hazards, worker and supervisor training is important. In addition to raising awareness about heat-related health effects, training informs workers about how the heat illness prevention program works. High risk tasks can be addressed, hydration and scheduling elements can be explained, and the need for crews to look out for one another can be emphasized. Be sure everyone knows what steps to follow if a worker exhibits signs and symptoms of heat-related illness, whom to call for medical help and who will provide first aid until an ambulance arrives.

It is best to train workers before hot outdoor work begins and then to reinforce key aspects using toolbox talks and other options. OSHA provides access to many training materials, including posters, videos and social marketing campaign materials, at https://www.osha.gov/heat/index.html.

Monitoring

Guidance for monitoring workers for heat-related illnesses was developed for use at hazardous waste sites, where high-risk heat conditions prevail because outdoor work must often be performed while wearing full impermeable suits and respirators. These guidance options are available at https://www.osha.gov/SLTC/heatillness/heat_index/monitoring_workers.html.

OSHA and NIOSH recommend basic monitoring for moderate and higher risk levels. For *moderate risks*, monitoring relies mainly on direct observation, such as setting up a buddy system to enable workers to watch for signs and symptoms of heat-related illness. Often, a worker will not recognize his or her own signs and symptoms. Monitoring also includes instructing supervisors to watch workers for signs of heat-related illness. Check routinely to ensure workers are making use of water and shade and not experiencing symptoms of heat-related illness.

For *high-risk* conditions where heavy or nonbreathable clothing or impermeable chemical protective clothing is to be used, additional measures are added to physiologically monitor workers. This means setting up a routine to periodically check workers for physical signs (e.g., body temperature and heart rate) to help manage the risk of heat-related illness. The results can be used to adjust work and rest periods.

For *very high to extreme temperature risks*, the recommendation is for all workers to be physiologically monitored. A full discussion of physiological monitoring options is available at https://www.osha.gov/SLTC/heatillness/heat_index/monitoring_workers.html.

Regulations and Guidance

United States

There are currently no specific OSHA standards for occupational heat exposure. OSHA has used the general duty clause provision — Section 5(a)(1) of the Occupational Safety and Health Act

— for enforcement on heat exposure cases. Under this clause, employers are required to provide their employees with a place of employment that is "free from recognized hazards that are causing or are likely to cause death or serious physical harm to employees." For additional information, see https://www.osha.gov/SLTC/heatstress/standards.html.

Two states, California and Washington, have specific heat illness prevention provisions. Information on California Sec. 3395 is available at the "Heat Illness Prevention" topic page (https://www.dir.ca.gov/DOSH/HeatIllnessInfo.html) along with various training materials. Information on the Washington provisions can be found at their "Outdoor Heat Exposure" topic page (https://www.lni.wa.gov/Safety/Topics/AtoZ/HeatStress/training.asp) along with toolbox talks and other training materials.

Canada

Most Canadian jurisdictions use the ACGIH wet-bulb globe temperature (WBGT) TLV (see "Taking heat illness prevention to the next level" sidebar) for guidance and enforcement purposes. In Quebec, the WGBT calculation is codified in the legislation under Annex 5 of Regulation S-2.1, r.19.01. Some jurisdictions, such as Ontario, use a general duty clause approach based on their provincial occupational health and safety act when enforcement is appropriate. Another tool, called the humidex, has been developed as a quick reference assessment method similar to the heat index. See https://www.ccohs.ca/oshanswers/phys_agents/humidex.html for more information.

Good Practice

Construction employers should use the OSHA-NIOSH Heat Safety Tool app guidance as a basic good practice approach for managing high-temperature hazards.

How can trade groups help?

The many trade-specific employer and employee organizations in construction can work together to improve occupational health in construction and address this Focus Four hazard by educating their members about the hazards of temperature extremes, by developing work practices for known high-risk tasks and by providing model programs to be adopted by their organizations.

How can an industrial hygienist help?

Industrial hygienists can assist employers with recognizing, assessing and controlling hazards their employees are exposed to when working in temperature extremes.

Industrial hygienists can help establish, manage or oversee a heat illness prevention program; train supervisors on how best to perform hazard assessments; and help employers select the most appropriate engineering controls and protective measures, such as work-rest schedules.

Industrial hygienists can be especially helpful for targeting high- and very-high-risk-level tasks and conditions. They can provide more accurate supplemental measurements to help tailor precautions and programs. (See sidebar on "Taking heat illness prevention to the next level.") They can also assist with identifying helpful emerging technologies for addressing heat, and with arranging for appropriate physiological monitoring.

Takeaway Messages

1. High temperatures and hot periods are increasingly common. In addition to the significant health hazards, high-temperature work also presents a significant productivity issue. Every construction employer needs to include this hazard in his or her safety and health program.
2. Heat illnesses such as heat stroke can kill, so on-site supervisors and employees need to know the symptoms, watch out for one another and get medical help right away if any symptoms are noted.
3. The heat index is not the only important consideration. Construction risk factors can play an important role in magnifying the impact of heat. Factors such as work in direct sun, work in confined areas use of PPE and other workload factors should be taken into account during planning.

4. Ignoring acclimatization is asking for trouble. Of 13 heat illness deaths investigated by OSHA, 9 occurred on the first three days of the job — and 4 of the 9 occurred on the very first day of the job. Most construction jobs are short term in nature, and new and returning workers are a daily occurrence for some jobs. Do not overlook acclimatization.
5. Most high-temperature hazards can be addressed using basic measures, such as week-ahead planning; scheduling; training; and providing water, rest periods and shade.
6. If the work performed by your construction firm or employer includes high- or very-high-heat-exposure tasks and operations, consider getting outside help to make sure your heat illness prevention program is safe and effective.
7. Site leadership that is sensitive to these hazards is important for managing high temperatures. On-site managers need to take the lead in ensuring supervisors and workers take the dangers of heat seriously. Construction workers are not likely to voluntarily stop work if they are being affected by the heat unless their bosses make it clear that preventing heat stress is important. Workers who have experienced heat stress symptoms during a shift may want to return to work after a rest break even though that may not be advisable. Supervisors need training to ensure they can recognize and act on signs of heat stress in their workers.

Additional Resources

OSHA's occupational heat exposure topic page is located at https://www.osha.gov/SLTC/heatstress/. OSHA, working with Cal/OSHA, developed a campaign to keep workers safe while working in the heat: https://www.osha.gov/heat/index.html. This includes guidance developed to help employers use the heat index as a guide for evaluating heat hazards: "Using the Heat Index: A Guide for Employers." OSHA's Technical Manual also includes a chapter on heat stress.

NIOSH also has a heat stress topic page that includes links to various materials. For example, NIOSH has blog articles about acclimatization at https://blogs.cdc.gov/niosh-science-blog/2014/07/14/acclimatization/ and https://blogs.cdc.gov/niosh-science-blog/2011/08/12/heat-2/. The NIOSH "Criteria for a Recommended Standard: Occupational Exposure to Heat and Hot Environments (Revised Criteria 2016)" provides a comprehensive review of the available evidence about heat illnesses and prevention.

CDC's "Heat Illness and Death Among Workers — United States, 2012 2013," summarizes findings from recent heat illness deaths.

You should know …

Taking heat illness prevention to the next level

Are you located in an area where triple-digit temperatures are common? Do you specialize in work that involves full PPE use or similar high-temperature risk factors? Or would you like to be more confident your program is sufficient?

If so, you should know about the wet-bulb globe temperature (WBGT) measurement. It is more accurate than the heat index because, in addition to temperature and humidity, it also accounts for the effects of direct sunlight and wind speed. The WBGT is the measurement relied on by industrial hygienists, and it is the one most commonly specified in standards.

Heat stress-related standards that use the WBGT include the following:

- NIOSH REL
- ACGIH TLV (adopted by some Canadian provinces)
- ISO (International Organization for Standardization) 7243

These standards also include estimation methods for workload and clothing adjustments.

CPWR provides a variety of resources and toolbox talks on heat illnesses at https://www.cpwr.com/research/working-hot-weather.

Canadian resources include the province of Saskatchewan's Working Outdoors page at https://www.saskatchewan.ca/business/safety-in-the-workplace/hazards-and-prevention/safety-in-professions-and-industry/working-outdoors#working-in-hot-conditions, which includes information on working in hot conditions.

WorkSafe BC provides useful awareness and training materials on heat stress at https://www.worksafebc.com/en/health-safety/hazards-exposures/heat-stress. See also "Preventing Heat Stress at Work."

The province of Alberta developed best practices for working in the heat or cold. They are available at https://work.alberta.ca/occupational-health-safety/working-in-extreme-temperatures.html.

The Occupational Health Clinics for Ontario Workers organization has a heat stress awareness topic page at https://www.ohcow.on.ca/heat-response-handouts.html. It includes posters, guides, a simple humidex calculator and a humidex-based heat response plan.

The Canadian Centre for Occupational Health and Safety provides information on control measures for hot environments.

Information from the Ontario Ministry of Labour is located at https://www.labour.gov.on.ca/english/hs/pubs/gl_heat.php.

Information on existing voluntary standards can be found at American Conference of Governmental Industrial Hygienists (ACGIH). See" Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices."

Information on the topic of contact with hot surfaces is available via the ISO/TC13732-Series: "Ergonomics of the Thermal Environment —- Methods for the Assessment of Human Responses to Contact With Surfaces."

- Part one: Hot surfaces
- Part two: Surfaces at moderate temperatures

WHAT CAN YOU DO? IDEAS FOR HEALTH ACTIVITIES

We hope this guidance has provided ideas you can use to raise awareness and generate activities related to these Focus Four for Health hazards. The construction industry benefits from a large community of active organizations and groups. There are plentiful opportunities for partnerships and activities at all levels, from local all the way to national. Here are some ideas to get you started.

Trade Associations

Many trade associations have safety and health committees that meet regularly to address topics of interest and develop industry-specific guidance. Put Focus Four for Health on your agenda for discussion and activity. For example, how do these hazards affect your specific trade? Does your trade have existing training materials and guidance on these topics? Each of the four topics addressed in this document includes specific ideas for trade association collaboration.

Labor Organizations

Many construction unions have safety and health committees that meet regularly as well. Put Focus Four for Health on your agenda for discussion and activity. How do these hazards affect your trade? Does your trade have existing training materials on these topics? What do apprentice training materials say? For example, do they point out the five loudest tools used in your work?

Construction Trainers

A strong network of training providers offers 10- and 30-hour training courses sanctioned by OSHA to construction workers and supervisors. Most of this training is on safety, but health issues can and should be included. Training providers can play an important role in developing and delivering new high-quality training classes on the Focus Four for Health topics.

Workers' Compensation Carriers

Insurance providers have ongoing relationships with construction employers. These relationships tend to spotlight safety and injury prevention. Workers' compensation carriers are increasingly involved with musculoskeletal disorders, opiate use in medical care and other health issues. This Focus Four for Health document provides a mechanism to develop new partnerships and activities to prevent costly health impacts.

OSHA, State and Provincial Groups

Federal, state and provincial agencies have many opportunities to initiate Focus Four for Health activities. For example, OSHA, through its Directorate of Construction, can raise awareness about this initiative by putting it on the agenda for discussion at stakeholder meetings. OSHA can help encourage the development of new training materials and new partnerships, especially with existing volunteer groups. OSHA can also encourage local, area and regional offices to partner with interested local construction groups. States and Provinces are also well-positioned to encourage partnerships on this initiative.

In addition, OSHA along with state and provincial counterparts, can initiate internal reviews to ask why health lags behind safety in construction regulations, inspections and consultations. It can engage partners to generate new approaches to raise the profile of health hazards. OSHA has run a social marketing campaign on heat stress; the agency could use social marketing ideas to raise awareness on other health topics. The OSHA Directorate of Construction and the OSHA Directorate of Enforcement could work together to identify ways to better target construction health hazards.

NIOSH and Research Organizations

NIOSH research has provided a valuable foundation for understanding exposures and developing practical solutions for the Focus Four for Health topics. NIOSH, through its Office of Construction Safety and Health, can partner with other groups to develop new informational products to communicate emerging research and findings, and can work with partners to target research to new data gaps — or promising areas such as prevention through design.

NIOSH's Health Hazard Evaluation program is also available for employers and other groups that would like evaluations

of worksites. Most of the requests for these evaluations have come from general industry, but the program could be used more often by construction organizations.

Safety and Health Organizations

Organizations such as AIHA and the American Society of Safety Professionals can serve as champions to stimulate Focus Four for Health activities via advocacy, meetings, publications and partnerships at the local, state and national levels. Each of these groups has committees that focus on the construction industry.

These groups can play a significant role in providing subject matter expertise to organizations and employers. For example, local AIHA chapters could collaborate with local construction trade associations, labor organizations and local OSHA offices to conduct workshops and training sessions. Or they could work with local tool rental suppliers and vendors, for example to demonstrate quieter tool options and noise measurement apps. Safety and health organizations can also help lead efforts to use social media platforms to share materials and success stories.

Owners

The customers and organizations paying for construction work have substantial influence on contractors. Owners are beginning to include safety in project design criteria and contractor selection.

How about health? Construction noise is a top community complaint; more and more local codes are addressing it. This is especially true for school and hospital construction or renovation, where noise disturbs students or patients. Calling for low-noise methods to be used is possible and should be encouraged. Health is a good fit with efforts to build using green and sustainable approaches.

Employers and Employees

The stakes are highest for construction employers and employees. For employers that have worked primarily to reduce safety hazards, Focus Four for Health provides a readily available way to start tackling health hazards. Get involved with the organizations you belong to. Do not underestimate your own contributions. Sharing your experiences — both challenges and success stories — takes time but is extremely valuable to others. Suggesting new types of products, tools or training materials you think are needed is also very helpful.

Closing Messages

Construction is a vital industry. Construction employers and workers build our roads and new buildings and maintain our historic buildings and infrastructure.

While preventing injuries is critical, so is keeping workers healthy. For a variety of reasons, efforts to improve health have lagged efforts to improve safety. This must change.

These Focus Four for Health materials provide a way to get started. The four health topics selected — manual material handling, noise, air contaminants and high temperatures — reflect hazards common to nearly all construction projects. The guidance we have offered provides key information and practical steps employers can take to make real progress on reducing these health hazards.

This does not mean these are the only health hazards that are important in construction. There are other health hazards, such as vibration, cold temperatures or skin exposures to chemicals. We believe that tackling the Focus Four for Health hazards will give employers and organizations experience and skills they can use to take on other priority health hazards that are relevant to them.

We intend to review these materials regularly. If you have questions, comments, suggestions, data or photos you wish to share, please send them to the AIHA Construction Committee at tla@aiha.org.