Respiratory Protection in the Age of Coronavirus

We have the technology to keep hazardous contaminants out of the air we breathe

BY TOM O'BRIEN

When 2020 began, the sight of folks wearing face masks who weren't performing manual labor, treating patients, or robbing banks was inconceivable. As this dreadful year draws to a close, face coverings are ubiquitous but NIOSH-approved respirators are more elusive than an ivory billed woodpecker. COVID-19 is a hard reminder that good health cannot be taken for granted.

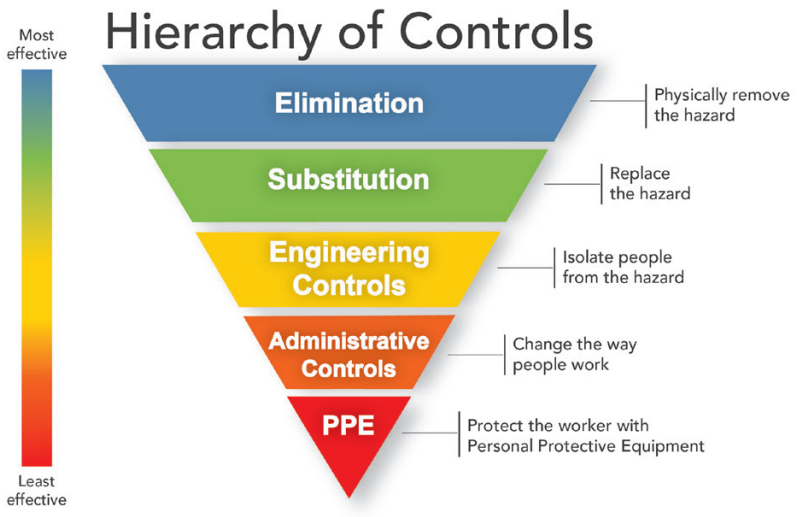
We've learned some valuable lessons this year: Jobsite hygiene is no laughing matter; airborne contaminants can be breathed out as well as in; an effective respiratory protection plan cannot solely depend on a filter over the face; and, perhaps most important, for people with compromised respiratory systems, some viruses can be lethal.

"This is the year of the lung, so to speak," says Michelle Kelley, spokesperson for Oneida Air Systems, a manufacturer of dust control systems for jobsites and woodworking shops. "Hopefully, people will be more aware of how much damage breathing in airborne hazards such as silica, and even sawdust, can do over the long haul."

CLEAR THE AIR

According to the American Industrial Hygiene Association (AIHA), 15.2% of construction workers over the age of 50 suffer from some form of lung disease, a rate that's almost twice as high as that for white-collar workers. Another disturbing statistic comes from

Photos by Tom O'Brien



Much like the Food Guide Pyramid that it resembles, NIOSH's Hierarchy of Hazard Controls ranks health and safety controls in order of decreasing effectiveness. Like red meat, PPE should be used sparingly and in small portions.

CDC-NIOSH health communication specialist Nura Sadeghpour: "53,000 workers die annually from occupational diseases, almost 10 times the number who are killed by traumatic injuries."

Airborne respiratory hazards are categorized as dusts, mists, fumes, gases, or vapors. The first three are particles—dusts are solid particles, mists and fumes are the liquid variety. All of these can be captured with particulate filters (HEPA being the most efficient option). Gases or vapors in the air require filtering elements tailored specifically to the nature of the contaminant. But no law says that those filters have to go on the face.

This year, every human being knows what it's like to wear a face mask, if not a respirator, for an extended period of time: It's uncomfortable, inefficient, and potentially harmful, especially when you're doing strenuous labor in a dusty environment.

When employers make plans to address airborne health hazards, the U.S. Occupational Safety and Health Administration (OSHA) leaves no doubt in its Air Contaminants Standard [1910.1000(e)] that the respirator shall not be the first choice:

"To achieve compliance ... administrative or engineering controls must first be determined and implemented whenever feasible. When such controls are not feasible to achieve full compliance, protective equipment or any other protective measures shall be used to keep the exposure of employees to air contaminants within the limits prescribed in this section."

HIERARCHY OF CONTROLS

The National Institute for Occupational Safety and Health (NIOSH)—as well as AIHA, OSHA, and every other lettered organization that promotes health and safety—urges employers to design their protection protocols using a rubric that ranks five categories of hazard control from most effective at risk reduction to least (see "The Hierarchy of Hazard Controls," left).

Here are some examples of jobsite procedures that fit the categories in this hierarchy:

Elimination: Encapsulate asbestos or leaded paint instead of removing it.

Substitution: Remove paint using nontoxic liquid stripper.

Engineering Controls:

- Use wet saws and drills when cutting masonry products.
- Use shrouded power tools connected to HEPA vacs to capture dust at the source.
- Use air scrubbers to capture whatever gets away, and provide good separation between the work area and occupied areas of the building to ensure air between them does not mix.

Administrative Controls:

- Keep the jobsite clean.
- Set up the cutting station outside.
- Train all employees on proper procedures for dust control practices.
- Inspect and maintain equipment to prevent malfunctions that might allow contaminants to escape.
- Coordinate with subcontractors to minimize demolition and do all of it at the same time.
- Schedule hazardous work practices for times when no other workers are present.

Personal Protection Equipment: Use respirators (specifically "filtering facepiece respirators," as we shall describe in detail below).

Generally speaking, PPE is the least effective means of providing health and safety protections, because it does not eliminate the hazard and leaves the wearer exposed to it if the equipment is damaged or poorly maintained.

That's not to say that all forms of PPE should be done away with. "Eye and hand protection can never be minimized," says Ken Tucker, director of the Connecticut Department of Labor Division of Occupational Safety and Health (CONN-OSHA), "but we try to avoid the need for respirators as much as possible."

Rob Robillard, owner of A Concord Carpenter, follows an all-of-the-above approach to keeping the air clean. "We're using air scrubbers when it makes sense, we're using ZipWalls when it makes sense, we're collecting dust at the source, and we're vacuuming with HEPA vacs, sometimes multiple times a day, to keep the dust down."

Manufacturers have a burgeoning array of attachments that enable workers to work safely at almost every dirty job (even paint-scraping). Shown above (clockwise, from upper left): Festool Drilling Dust Nozzle D 27-BSD, Oneida Air Systems Viper Vacuum Scraper, Oneida Air Systems Dust-Free Router Hood, Bosch HDC200 Universal Dust Collection Attachment.

LEAD PAINT AND SILICA RULES PAVE THE WAY

Not long ago, dust extraction was a two-person job: One would operate the saw, drill, or whatever, and the other would hold a vacuum hose close enough to the cutter to suck up the dust. By the mid-1990s, innovations such as tool-operated vacs and dust shrouds were catching on. But it took the government to goose the market.

Demand for dust controls got a kick in the pants in 2008 when EPA's Renovation, Repair and Painting (RRP) regulations went into effect, and a shot in the arm in 2017 when OSHA instituted the Respirable Crystalline Silica Standard (1926.1153). Although plenty of contractors grumbled about the onerousness of these rules, the swelling demand for dust-control solutions spurred toolmakers to flood the market with innovative methods to capture dust at the source and filter the breathable air. Highlights include:

- Almost all power tools are factory-equipped for dust collection.
- Third-party manufacturers such as Oneida Air Systems (oneida-air.com) and Dustless Tools (dustlesstools.com) have come out with dust-capturing hand tools, as well as shrouds that enable older power tools to work dust-free.
- Reasonably priced tool-operated HEPA vacs are commonplace (some feature Bluetooth capability for pairing with cordless tools).
- Cyclonic dust collectors (staples in woodworking shops) have arrived on the jobsite, both in the form of standalone units, and as pre-sorters for HEPA vacs—to separate out the larger dust particles so they don't clog the filter.
- Air scrubbers (aka "negative air machines") have gotten more portable and more affordable.

TABLE 1 FROM THE OSHA SILICA STANDARD

Equipment / Task	Engineering and Work Practice Control Methods	Required Respiratory Protection and Minimum Assigned Protection Factor (APF)	
		≤ 4 hours /shift	> 4 hours /shift
Hand-held power saws (any blade diameter)	Use saw equipped with integrated water-delivery system that continuously feeds water to the blade.		
	Operate and maintain tool in accordance with manufacturer's instructions to minimize dust emissions.		
	When used outdoors:	None	APF 10
	When used indoors or in an enclosed area:	APF 10	APF 10

In this example, if a worker uses a saw outdoors for four hours or less per day, no respirator would be needed. If a worker uses a saw for more than four hours per day or any time indoors, he or she would need to use a respirator with an assigned protection factor (APF) of at least 10. A NIOSH-certified filtering facepiece respirator would provide this.

PERMISSIBLE EXPOSURE LIMITS

The aim of engineering controls such as these is to keep airborne contaminants out of a worker's "breathing zone" (within 10 inches of a worker's face). Unless the concentration of respirable hazards exceeds the Permissible Exposure Limit (PEL), respiratory protection is not required. PEL is expressed in terms of micrograms (µg) of airborne contaminant per cubic meter (m3) of breathable air over the duration of an eight-hour workday. Prior to 2017, the PEL for quartz, cristobalite, or tridymite (the three most common forms of crystalline silica) was 250 µg/m3. OSHA's silica rule slashed it to 50 µg/m3.

In years past, employers were on their own when they used the Hierarchy of Controls to design safety protocols that protected workers without forcing them to suit up like HazMat teams; they had to come up with their own dust-containment plan and be prepared to provide evidence—such as air-sampling testing data—to prove its effectiveness. That's not the case with the silica rule.

"It's a massive step forward. One of the best things that OSHA could have done to help the employer comply with a mandate," says Ken Tucker of CONN-OSHA. What he's specifically referring to is

Cyclonic dust extractors can suck up large volumes of dust without clogging filters. Large stationary units are common in woodworking shops, but there are several portable types available now, as well. At left is an "add-on" version, which requires you to use your own vacuum; at right is an all-in-one unit.

Table 1, a chart that zeros in on 18 common work practices that involve silica and specifies procedures to be followed and what (if any) PPE is required for the task (see sample, previous page; for the complete Table 1, search online for "OSHA Table 1 silica"). Employers who adhere to the general mandates of the silica rule and follow the methods prescribed in Table 1 have no further obligation to prove the effectiveness of their silica safety plans. "If you follow the script, use the wet methods, use the dust collection systems, or whatever it may be, there's no need for air monitoring," says Tucker.

OSHA IS NOT YOUR FRENEMY

Although the silica standard applies to only one type of hazardous dust, the practices and controls specified in Table 1 attest to the effectiveness of capturing dust at the source. For proof, look at the number of situations where respiratory protection is not mandated. For instance, if a contracting firm upgraded its arsenal of dust collection devices and reconfigured its safety protocols to align with the Hierarchy of Controls, how would it determine under what situations respiratory PPE might still be needed?

The quantitative solution is to hire an industrial hygienist, or other specialist, to test the concentration of hazardous particles in a worker's breathing zone as they're performing potentially hazardous tasks. Air monitoring of this type is relatively easy to do in a shop or a factory, but significantly more complicated when the environment changes from job to job.

For budget reasons, home builders and remodelers might be better advised to seek a qualitative solution to the question. If they can get over their (understandable) hesitation to invite an OSHA representative onto their jobsite, help is just a phone call away.

The On-Site Consultation Program (osha.gov/consultation) is designed to provide advice, consulting services, and training (all free of charge) to small businesses that do hazardous work. Although it's federally funded, this program is administered at the state level. Consultants who visit jobsites are not empowered to issue citations or report safety violations.

"We don't share any information with the Feds," says Ken Tucker, who oversees Connecticut's On-Site Consultation Program. "We go out at an employer's request, and limit our investigation to what's asked of us. After evaluating the work practices and exposures, we write up a report that goes to the employer and no one else. It's 100% anonymous."

Air sampling is among the free services offered by the consultation program, but Tucker has rarely seen the need for it on residential construction sites. "Monitoring may be done, but we try to look

"Air scrubbers" are designed to sit in the middle of a work area and pull air through a cyclonic extractor (as in the Vortex Duct One unit, at left) or through HEPA filters (as in the Pullman-Ermator A1000, above). When the exhaust is ducted outdoors, an air scrubber can create negative pressure in the work area that can help keep contaminants out of other areas in a building.

at what we can do to use engineering controls and administrative controls to reduce exposures," he says.

RESPIRATORS 101

A well-thought-out safety protocol should reduce the need for wearable respiratory protection to a handful of dirty jobs—demolition, insulation, paint preparation, and spray painting, for example—wherein airborne contaminants are not easily contained. When respiratory protection is mandatory, it's because the concentration of airborne contaminants swirling around a worker's face constitutes a serious health threat. Choosing proper protective devices cannot be taken lightly.

There is no such thing as a dust mask. Every NIOSH-approved wearable device that filters the air is a respirator, whether it's disposable or reusable. The technical term for a disposable one is "filtering facepiece respirator" (FFR); that means that the entire mask, apart from the straps, is a filter, and, just like a cartridge filter, when it has outlived its usefulness, it must be discarded.

Reusable respirators fall into two categories: air purifying and air supplying. Air-purifying reusable respirators function the same as FFRs, except that they rely on replaceable cartridges for filtration; they're also more versatile because they can be fitted with a variety of filter cartridges to protect the wearer from different categories of airborne contaminants. Air-supplying respirators rely on fresh air being pumped into the mask, like a scuba diving setup. These devices are expensive and are rarely seen in residential construction.

In order to choose the proper air-purifying respirator for a particular job, you may need three pieces of information:

1. Assigned protection factor (APF).
2. Nomenclature (for FFRs).
3. Nature of airborne contaminant.

APF refers to the level of protection. An APF of 10 means that the respirator (if properly fitted) can safely be worn in an environment where the airborne contamination is as much as 10 times the PEL. NIOSH-approved FFRs and reusable half-mask respirators both have an APF of 10. A full-face reusable respirator (the kind that looks like a gas mask) can achieve an APF of 50. Although APFs range as high as 10,000, anything over 50 requires battery power or supplied air.

FFRs are only suitable to filter particles (dusts, mists, or fumes). They are classified by a letter, which refers to oil-resistance, followed by a number, which designates filtration capability. The N95 that we hear so much about these days is not oil-proof, and is designed to filter 95% of airborne particulates. An R95 is oil-resistant; a P95 is oil-proof. An N, R, or P100 can filter 99.7% of particulates and qualifies as HEPA.

Contaminants other than particulates require a reusable respirator with replaceable cartridge filters, which are color-coded by the hazard they protect against (see table on next page, bottom left).

A NIOSH-approved disposable filtering facepiece respirator (FFR), such as an N95 (above left) or N100 (above right) can be used for protecting workers from particulates, but not vapors and gases. These models have double head straps, which provide a better seal than the ear loops found on KN95s.

A reusable half-mask respirator (above) with the right color-coded filter (below) can protect workers from particles as well as hazardous vapors or gases.

Filter Color	Hazard
Magenta	Particulates (HEPA)
Black	Organic vapor
White	Acid gas
Green	Ammonia and methylamine
Yellow	Organic vapor and acid gas

FITTING

Everyone who needs a respirator on the job must be cleared by a doctor and fit-tested annually to ensure that the mask seals tightly to the face. FFRs are one-size-fits-all, but reusables are manufactured in small, medium, and large. Beards are not permissible unless the facial hair is entirely within the seal. For more information about an employer's responsibilities under OSHA's Respiratory Protection Standard, search online for "OSHA 29 CFR 1910.134."

MAINTENANCE

As they fill up with debris, particulate filters become more effective, but less comfortable; a good rule of thumb is to replace a particulate filter when you notice an increase in breathing difficulty. Gas and vapor filters are more problematic, because they soak up contaminants like a sponge but lose their effectiveness when saturated. The only way that workers can become aware that one of these filters needs to be changed is if they smell the contaminant, but by that time they've already been exposed. To make sure that never happens, contractors can set up a cartridge change schedule, based on the nature of the contaminant, airborne concentration, and duration of exposure. Fortunately, there's an app for that: Visit the NIOSH website (cdc.gov/niosh), and enter "multivapor" in the search box.

After you have worn a respirator for hours in a sweaty, dusty environment, you will have created a Petri dish. To prevent lung infections or facial dermatitis, a reusable respirator must be cleaned at the end of every workday. Best practice is to take it apart and thoroughly scrub it with soap and water. Second best is to use wet wipes that are specifically designed to clean respirators without damaging the silicon.

COVID-19 CONCERNS

Almost a full year has elapsed since bells first rang out in warning about a previously unknown, highly contagious respiratory virus, yet severe shortages of vital PPE such as NIOSH-approved N95s persist to this day. One bright spot (perhaps) is that countries that have successfully contained the pandemic are shipping their surplus FFRs to us. Shelves in supply houses that once held N95s are now filling up with KN95s. What's the difference? Besides cost (demand has driven up costs of FFRs), the short answer is that a KN95 respirator is the Chinese equivalent of an N95. The filtering element is equally effective, but one area of concern is that most KN95s have ear loops, rather than adjustable head straps, which make achieving a tight fit to the face more difficult. For more information about which makes of imported PPE might be safe to use, visit the NIOSH website (cdc.gov/niosh).

Until medical professionals and first responders are stocked up, builders would do well to focus their safety plan on the Hierarchy of Controls and lessen their reliance on PPE. With proper planning and diligence, it's conceivable that the only place a construction worker might be required to strap on a face mask is at the grocery store.

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