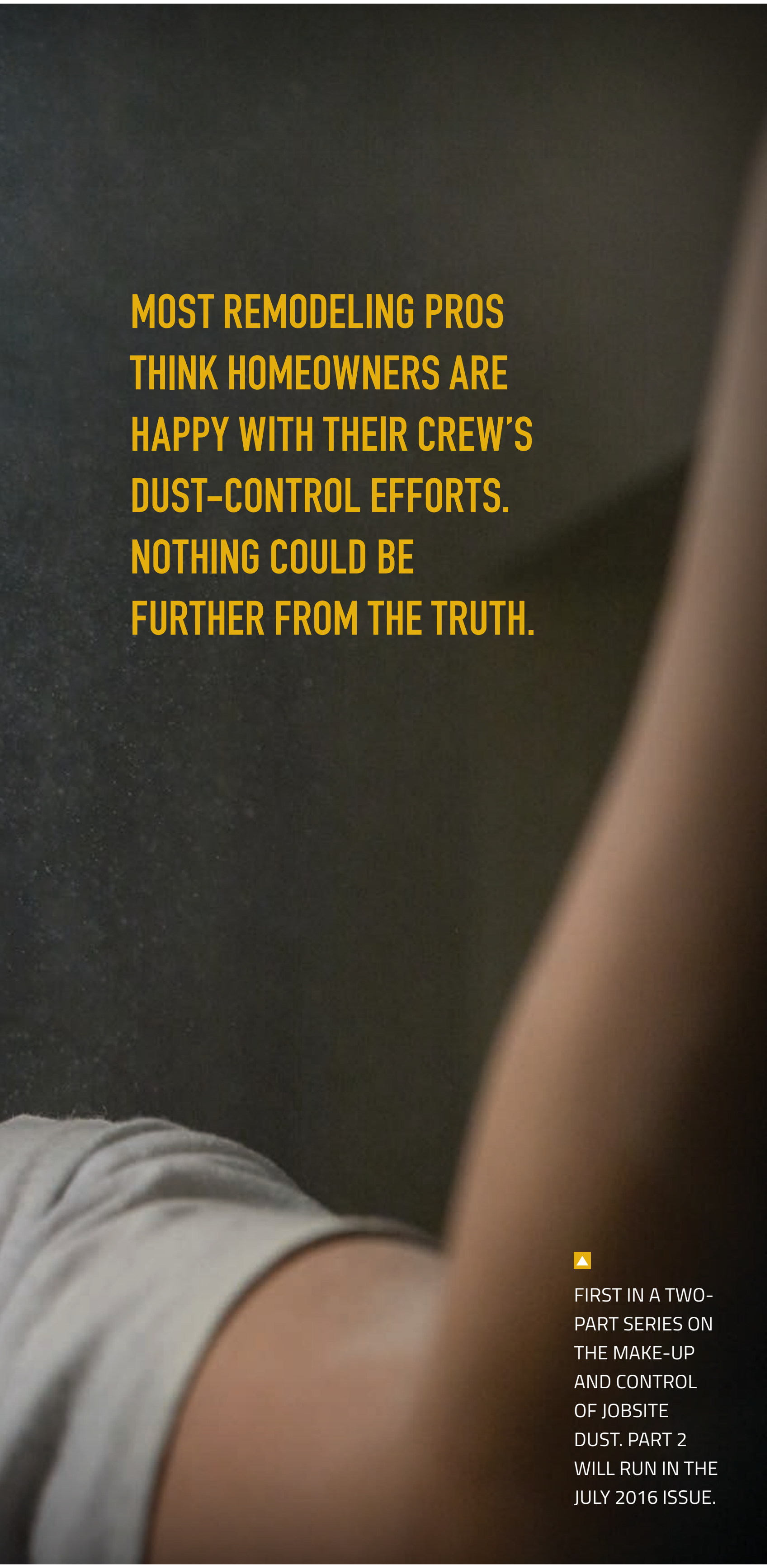
The Dirt on Dust

DUST ISN'T JUST A NUISANCE BYPRODUCT OF REMODELING; IT'S NASTY STUFF THAT'S BAD FOR EMPLOYEES, BAD FOR SUBS, BAD FOR CLIENTS—AND BAD FOR BUSINESS



MOST REMODELING PROS THINK HOMEOWNERS ARE HAPPY WITH THEIR CREW'S DUST-CONTROL EFFORTS. NOTHING COULD BE FURTHER FROM THE TRUTH.

FIRST IN A TWO-PART SERIES ON THE MAKE-UP AND CONTROL OF JOBSITE DUST. PART 2 WILL RUN IN THE JULY 2016 ISSUE.

PHOTO: COURTESY ITW

BY AMANDA VOSS, WITH SAL ALFANO / DIRECTOR OF CONTENT

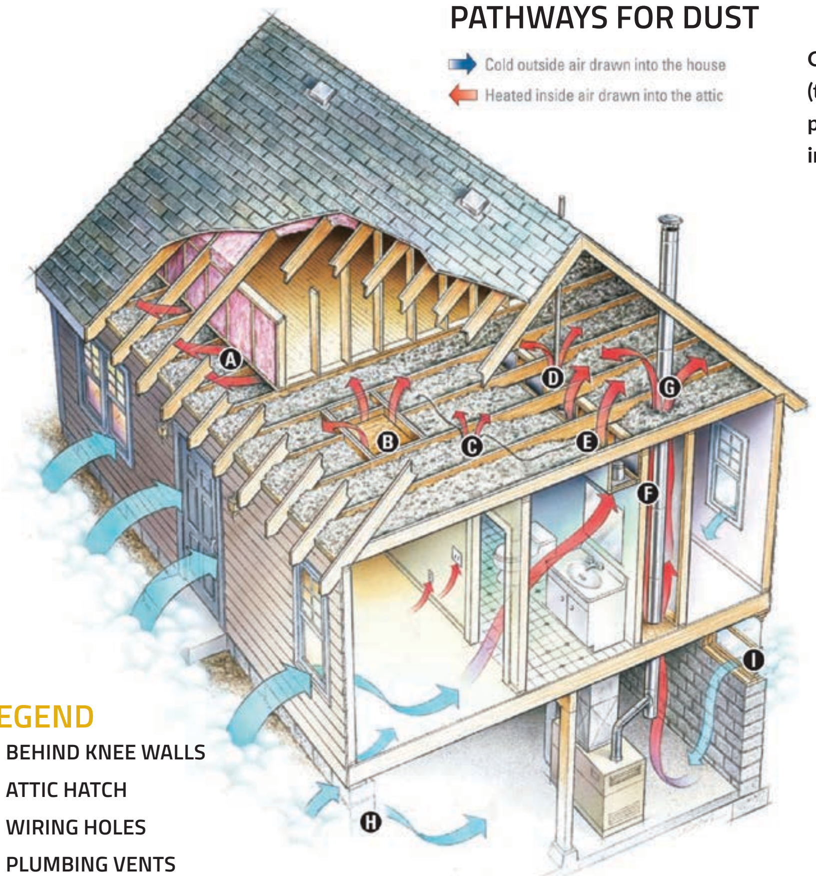
Dust is inevitable in remodeling. There's almost no task a remodeler can undertake that doesn't generate dust, and there are many commonplace tasks—for example, demolition, drywall cutting, and sanding—that produce copious amounts of the stuff. Most remodelers put up makeshift "tents" using poly and painter's tape in a halfhearted effort to keep dust from spreading throughout the house. But the attitude of many contractors is that it's a losing battle; a fact of remodeling life that they and their clients—the majority of whom want to stay in their home during the project—simply have to accept. But for some people, living with dust means living in physical discomfort—and maybe not living as long.

The U.S. Environmental Protection Agency's Lead Renovation, Repair, and Painting (RRP) rule is changing the attitudes and practices of remodelers working on houses built before 1978, but the dust problem goes beyond lead paint. Dust generated on remodeling jobsites is nasty stuff that gets into everything—not just floors, cabinets, closets, and electronics, but into the air inhaled by workers and by homeowners and their families. Failing to do whatever it takes to control construction-generated dust isn't just bad for business, it's bad for the health of your employees, your subcontractors, and your clients.

The Dust Disconnect

Ironically, preventing health problems is a leading motivation for home renovations. Forty percent of U.S. homeowners surveyed in the Houzz Healthy Homes Trend Study (October 2014) were motivated to remodel precisely because they wanted a healthier home. Moisture, air quality, and cleanliness topped the list of indoor issues that concern homeowners.

Most homeowners either want to stay in their home while it's being remodeled or have no choice in the matter. More and more are equally concerned about air quality during the remodel itself, particularly those who have lived through a past project. Unfortunately, when it comes to construction-related dust, there's a major disconnect



LEGEND

A] BEHIND KNEE WALLS

B] ATTIC HATCH

C] WIRING HOLES

D] PLUMBING VENTS

E] INTERIOR SOFFITS

F] RECESSED LIGHTS

G] FLUE OR DUCT CHASES

H] RIM JOISTS

I] WINDOWS & DOORS

Occupant movements, changing air pressure, and the stack effect (the tendency of warm air to rise) can propel dust-laden air through pathways in the structure created by plumbing lines, electrical wiring, recessed lights, and other common elements.

ILLUSTRATION: COURTESY ENERGY STAR / U.S. DEPT. OF ENERGY

between homeowners' concerns and the attitudes of remodelers. In market research completed for ITW (Illinois Tool Works) by MMR Research Associated, 89 percent of homeowners surveyed were concerned about "living through the project." While 64 percent of contractors acknowledged concerns about health issues during construction, only 39 percent reported taking any additional actions to manage the problem.

In fact, professional remodeling contractors reported feeling that homeowners are fairly satisfied with current dust management methods. Yet this couldn't be further from the truth: In research commissioned by ITW in connection with its BuildClean Dust Control System, of 251 homeowner respondents, 81 percent said they were unhappy about dust levels. And an astounding 85 percent stated that jobsite dust is the highest inconvenience of remodeling. For these clients, dust is worse than living with missing walls and plastic over the windows. It's worse than going without a kitchen sink or dishwasher, or with the refrigerator wedged into the living room. And it ranks above the constant noise of circular saws and heavy equipment.

And not just during the job, but afterward as well: Many homeowners told researchers that after the contractor's work is done, the presence of excessive dust required them to perform additional work themselves to complete the project.

What's in Dust?

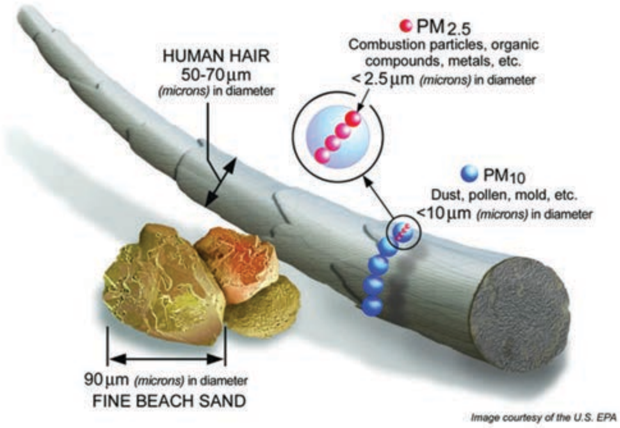
Every home has a background dust level, with the specific contents depending on a mix of factors. These include the age of the house, the number of people living in the residence, their activities, and the number and kind of pets they have. Household dust typically consists of some combination of: human skin flakes and animal fur; decomposing insect parts; food debris; lint and fibers from clothes, bedding, and other fabrics; tracked-in soil; soot and ash; particulate matter from smoking and cooking; and allergens and pollutants from the environment. Climate also affects the composition of dust. For example, research done by Lawrence Berkeley National Laboratory established that increased indoor humidity levels are associated with increased indoor dust mite allergen levels.

Jobsite Dust

During a typical remodeling project, multiple dust-generating events, such as demolition and drywall sanding, contribute additional components and an increased number of particles to the background dust level. Embedded within remodeling-generated dust is organic matter, such as rodent feces, dead bugs, dust mites, and mold spores; pulverized material remnants, like gypsum from drywall, silica from cement, and sawdust from wood; plus asbestos, lead, and VOCs (volatile organic compounds) from a variety of sources.

Most of the dust that homeowners see and complain about has settled on floors, countertops, window sills, bookshelves, trim and molding, and other surfaces. But many dust particles, including some that are too small to see, easily becomes airborne during normal household activity. Whenever people or pets move around, they stir up dust, either tracking contaminants inside from the outdoors, or tracking

HOW SMALL IS A MICRON?



Most particles in dust are very small. The diameter of the hair and fine beach sand pictured here are about 1/6 the diameter of the period at the end of this sentence.

ILLUSTRATION: COURTESY U.S. EPA

dust through the house from one space to another.

The HVAC system also moves dust around, as do natural pathways in a structure (see "Pathways for Dust," opposite page). As warmer air rises and cooler air falls, it carries dust particles with it, not just through rooms and hallways, but into and through unsealed stud, joist, and rafter bays. And every time someone opens a window or a door, the air pressure change can pull in contaminants from outdoors, and stir up tiny airborne dust particles that eventually resettle, only to be stirred up again in an endless cycle.

Size Matters

We all know what a coating of dust on a floor or countertop looks like, but there is a lot more going on in that fine, dry powder than meets the eye. Scientists categorize dust by size into three types according to how deep into the body the particles that make up each type can travel. The smaller the particle, the greater the penetration into the body and the greater the health risk (see "Breathing Dusty Air," page 43)

- **Inhalable** dust consists of particles 100 microns or less in diameter that can enter the mouth and nose during normal breathing.
- **Thoracic** dust comprises particles 10 microns or smaller in diameter that pass through the mouth and nose and reach the upper respiratory area.
- **Respirable** dust consists of particles less than 5 microns that can reach all the way into the alveoli of the lungs.

RELATIVE SIZE OF COMMON DUST PARTICLES

PARTICLE	SIZE (MICRONS)
Asbestos	0.7 – 90
Bacteria	0.3 – 60
Burning wood	0.2 – 3
Calcium zinc dust	0.7 – 20
Carbon black dust	0.2 – 10
Cement dust	3 – 100
Clay	0.1 – 50
Combustion	0.01 – 0.1
Corn starch	0.1 – 0.8
Fiberglass insulation	1 – 1000
Lead dust	2
Oil smoke	0.03 – 1
Paint pigments	0.1 – 5
Rosin smoke	0.01 – 1
Saw dust	30 – 600
Smoke (natural materials)	0.01 – 0.1
Smoke (synthetic materials)	1 – 50
Talcum dust	0.5 – 50
Tobacco smoke	0.01 – 4
Viruses	0.005 – 0.3

Common household dust contains many particles that are much smaller than 40 microns, which is the limit of what the unaided eye can see. The smallest particles can penetrate deep into the lungs and cause inflammation that leads to disease and reduced lung function.

40
MICRONS IN DIAMETER OF SMALLEST PARTICLE THE EYE CAN SEE

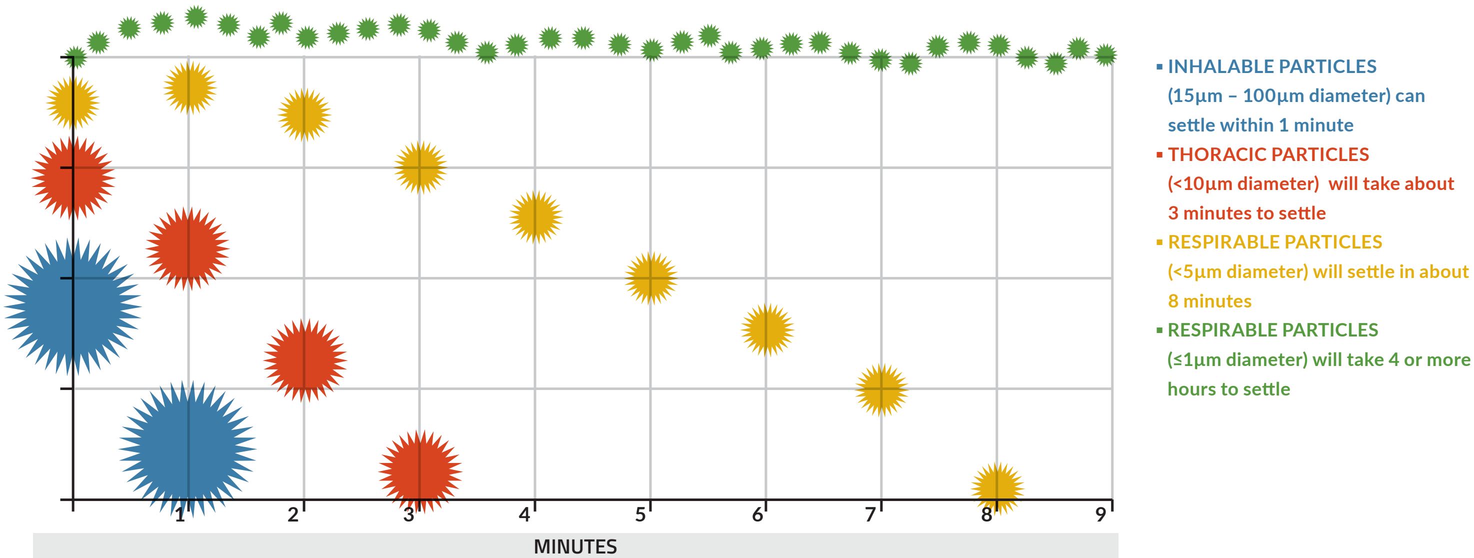
615
MICRONS IN THE PERIOD AT THE END OF THIS SENTENCE.

25,400
MICRONS IN 1 INCH

One measure of air quality is a count of the number of particles larger than 0.5 micrometers or "microns" (µm) in 1 cubic foot of air (see "How Small Is a Micron?" above, left). In the course of research done for ITW during development of the BuildClean system, air measurements were taken on active jobsites before, during, and after typical jobsite tasks. ARTI and Dylos airborne particle counters were used, both of which are capable of determining the dust concentrations of particles ranging in size from less than 0.3µm to 5.0µm. Sample readings are shown in the table "Construction Dust Profiles" (page 44), expressed as the number of particles in 1 cubic foot of air.

The results show that a typical room prior to construction activity averages 20,000 to 30,000 particles per cubic foot. (By comparison, a cubic foot

WHEN THE DUST SETTLES



Gravity causes most particles to settle out of the air within 10 minutes, longer if the air is stirred by activity or pressure changes. The larger air volume in big spaces may also increase settling times. The smallest particles may remain airborne for hours, and some may never settle out of the air.

DUST REMOVAL TESTING

PROJECT	COMPONENTS OF DUST	BACKGROUND DUST CONCENTRATION[1]	DUST CONCENTRATION DURING ACTIVITY[2]	DUST CONCENTRATION	
				at 3 mins.	at 10 mins.
Sawing wallboard	Gypsum, titanium dioxide, calcium carbonate, heavy metals	100,000	200,000	145,000	128,000
Cutting concrete	Cement, sand, silica, petroleum, organic matter	96,400	467,000	392,000	303,000
Sanding drywall	Gypsum, calcium carbonate	76,800	231,000	203,000	160,000
Plaster demo	Calcium, resin, heavy metals, asbestos, organic matter	88,200	528,000	481,000	389,000

[1] MEASUREMENTS OF PARTICLES GREATER THAN 0.5 MICRONS WERE MADE IN THE CENTER OF THE ROOM; BECAUSE MULTIPLE VARIABLES WERE INVOLVED WITH EACH TEST, THESE MEASUREMENTS PROVIDE "GENERAL" PARTICULATE LEVELS AND ARE NOT CONSIDERED SCIENTIFIC READINGS.
[2] IN MANY CASES, WORK HAD ALREADY BEEN PERFORMED BEFORE TESTING BEGAN, SO TRUE PRE-CONSTRUCTION BACKGROUND LEVELS MAY HAVE BEEN LOWER.

Tests done for ITW show changes in concentration of airborne particulates before and after common remodeling tasks were performed. Use of an air filtering system rapidly reduced dust concentration (see last two columns), and in most cases returned dust concentration to background levels after 1 hour of operation.

of air over the middle of the ocean or high mountains contains fewer than 200 particles larger than 0.5 µm.) When certain remodeling tasks are taking place, however, there is a much greater volume of particles in the air. Depending on the task being performed and what kind of dust management practices are being used, the data shows per-cubic-foot readings as high as 800,000 particles larger than 0.5µm. (In a follow-up to this article, the July 2016 issue of *Professional Remodeler* will explore materials and equipment for effective dust management.)

The concentration of particles is greater the closer you get to the work generating the dust, and is also affected by how long the particles remain suspended in the air (see "When the Dust Settles," above, top). Gravity pulls heavier particles to the ground sooner than lighter (and usually smaller) particles, which tend to float in the air for a longer time:

BREATHING DUSTY AIR

Under normal conditions, every cubic foot of air we breathe contains about 25,000 particles, most of which are too small to see (less than 40 microns in diameter). Fortunately, our respiratory tract is protected by mechanisms that work to keep our airways and lungs relatively clean.

Nose. When we breathe through the nose, air moves into the nasal cavity and sinuses where many airborne particles are trapped by a thin layer of mucus that lines the surface of the air passages. Fine hair-like structures called cilia continuously move the mucus (as many as four cups per day) into our throat, where most of it is swallowed. However, the quantity and viscosity of the mucus produced is affected by air quality. Allergens, for example, stimulate the immune system to send more blood to the nasal passages, which can cause swelling, inflammation, and increased mucus production. If the cilia can't keep up, congestion or a runny nose may result.

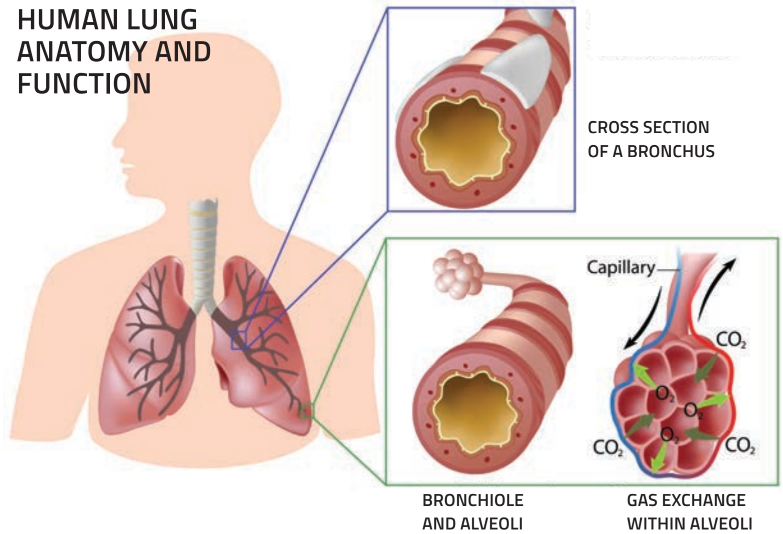
Bronchial tubes. Particles that make it through the nasal cavity—or that bypass it when we breathe through our mouth because of congestion or exertion—enter the trachea, then the bronchial tubes, whose trunk-and-branch passageways grow smaller the deeper into the lung the air travels. Here, too, the wavelike motion of cilia transports particle-laden mucus upward into the throat, where it is either swallowed or spit out.

Alveoli. The exchange of oxygen and carbon dioxide takes place in the smallest, deepest branches of the lungs, called the alveoli. Here there are no cilia, and the defense against particulates is taken over by microphages. These special cells engulf and consume particles, then make their way to larger passageways, where cilia push them up and out of the lungs.

Size, Shape, and Number

How the lungs react to the presence of particles depends on where the particles settle. The greatest danger comes from large quantities of small particles that reach the alveoli. Microphages that are overwhelmed may allow particles to collect in the lungs or may die before they are able to leave the lungs. In both cases, the result is the formation of scar tissue, or fibrosis. Over time, fibrosis can reduce the lungs' ability to expand and contract, which affects the efficiency of oxygen exchange. Certain substances do more damage than others; silicosis, for example, is a condition named for the crystalline silica particles that cause the inflammation that can very quickly lead to fibrosis and impaired lung function.

HUMAN LUNG ANATOMY AND FUNCTION



Most inhaled particles larger than 5 microns are captured by mucus in the nose and the relatively large lung airways (bronchi) and are prevented from entering the lungs. Smaller particles, however, can make their way into the narrowest passages of the lung (alveoli), where the exchange of oxygen and CO_2 takes place. Too many particles in these passageways can overwhelm the body's defenses, creating inflammation and a buildup of fibrous scar tissue that can lead to reduced lung function.

Small, irregularly shaped particles, such as the silica shown in this scanning electron microscope image, can become embedded in the deepest reaches of the lung, where they interrupt lung function and resist the efforts of the body's defenses to expel them.

SILICA IMAGE: COURTESY NIOSH / CDC; LUNG ANATOMY ILLUSTRATION: SHUTTERSTOCK.COM / ALILA MEDICAL MEDIA

DUST PARTICLE CONCENTRATION

30,000 PARTICLES/FT^3 · 250,000 PARTICLES/FT^3 · 515,000 PARTICLES/FT^3 · 800,000 PARTICLES/FT^3

OSHA's permissible exposure limit (PEL) for silica is 50 micrograms per cubic meter of air (µg/m^3), or about 840µg per 8-hour workday. A single 2x4-inch cut in a paver generates about 9 million micrograms of silica.

- Particles of 15µm–100µm in diameter (inhalable) can settle within 1 minute; in larger rooms, air volume will extend the time needed for settling.
- Particles less than 10µm in diameter (thoracic) will take about 3 minutes to settle.
- Particles at 5µm in diameter (respirable) will settle in about 8 minutes.
- Particles with a diameter of 1µm (respirable) will take up to 4 or more hours to settle.

CONSTRUCTION DUST PROFILES

Type of activity	Components of dust	Particle size	Particle count per cubic foot[1]
Before construction	General IAQ	< 1 – 100 microns	20,000 – 30,000
Demolition	Gypsum, cement, silica, sawdust, general dust/dirt/debris	< 1 – 200 microns	145,000 – 200,000
Framing	Sawdust, general dust/dirt/debris	20 – 200 microns	100,000 – 170,000
Sanding, cutting, grinding	Cement, sand, silica, wood fiber (sawdust)	0.05 – 150 microns	450,000 – 800,000
Drywall / plaster (demo, install, sanding)	Gypsum, silica, solids from coatings (i.e., resin, titanium dioxide, calcium carbonate, iron oxide, etc.)	< 1 – 200 microns	450,000 – 600,000
Flooring demo	Wood fibers, cement, sand, silica, asphalt, vinyl, cork, plastic, dirt	< 1 – 200 microns	150,000 – 200,000

[1] PARTICLES GREATER THAN 0.5 MICRONS

To determine the number of particles generated by more than one activity ocurring simultaneously, add together the readings from all activities.

Clearing the Air

ITW also measured how fast specific control measures could reduce the particle count on an active remodeling jobsite. The results of its tests show the drastic effect remodeling can have on indoor air quality, as well as the effectiveness of air containment measures (see "Dust Removal Testing," page 42). Similar air testing was recently performed by Bert Schiller, an independent certified industrial hygienist, in a 6,000-cubic-foot space (30x20x10). Results showed that just after the dust-generating event, particles greater than 0.5 microns in diameter reached counts in excess of 500,000 per cubic foot. A BuildClean unit was then turned on in the center of the room, and after 6 minutes, dust concentration dropped to roughly 140,000 particles per cubic foot; after 12 minutes (one complete air exchange), the dust concentration dropped to roughly 90,000; and after 1 hour, the particulate count fell to roughly 30,000.

Controlling Dust

The days of shrugging off the inevitability of dust in a remodeling project are over. In addition to the inconvenience and annoyance it causes homeowners and the increasing awareness of the potential health hazards a dusty jobsite presents, OSHA's newly revised silica rule makes dust containment and control a necessary part of a remodeling contractor's standard practices. In next month's issue, we'll explore the options for measuring dust levels and will talk with contractors about the materials, equipment, and jobsite practices they use to reduce or eliminate airborne particulates and protect homeowners and workers during construction. PRO

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