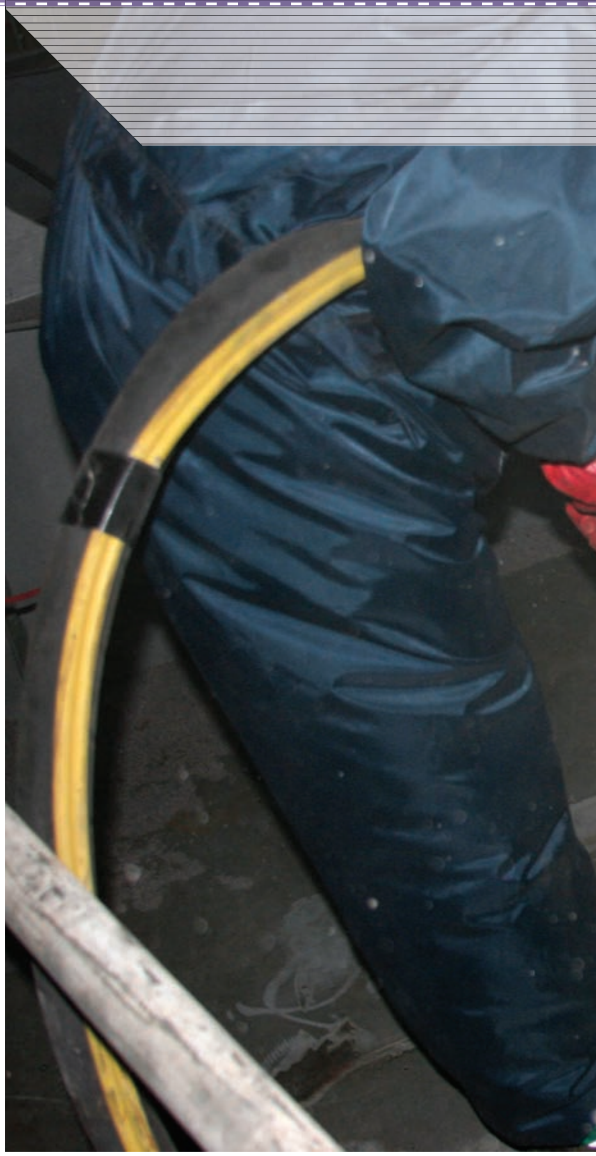
Healthy outlook

Abrasive blasting with sand substitutes is now used for cleaning, removing coatings, and creating surface-profile anchor patterns – and reduces the extreme health hazards to which workers are exposed

Jack Innis, Jamicha Co LLC



Silica sand, once widely used as an abrasive blast media, typically fractures into fine particles upon impact with a substrate and becomes airborne. Sandblasters, pot tenders, clean-up crews, and shipyard employees – such as painters, pipe fitters, welders, electricians, foremen, and inspectors – who inadvertently inhale crystalline silica dust may develop a lung condition called silicosis, which may lead to respiratory ailments, tuberculosis, and ultimately death.

The silica dust problem actually came to light in 1936 when pioneering British researcher E. R. Merewether discovered that 5.4% of a population of sandblasters (24 of 441) died from silicosis or silicosis-related issues over a 3.5-year period. Merewether's studies and those that followed led to the outright ban of silica sand as abrasive blasting material in the UK in 1947. Germany, Sweden, Belgium, and other countries soon followed suit.

In an effort to protect valuable workers by reducing extreme health hazards associated with silica dust, many shipyards, including those not affected by the ban, joined the switch from silica sand to abrasive sand substitutes such as coal slag, copper slag, nickel, crushed glass, steel grit, specular hematite (barshot), garnet, staurolite, and treated sand. Along with development of better PPE (personal protective equipment) such as air-supplied hoods, incidences of silicosis and silicosis-related health problems greatly decreased over the decades.

But studies now show that while sand substitutes create low or even undetectable levels of airborne crystalline silica, they produce dangerous and potentially lethal levels of other airborne contaminants such as arsenic, beryllium, cadmium, chromium, lead, manganese, nickel, titanium, and vanadium.

According to a US CDC (Centers for Disease Control) report titled *Evaluation of Substitute Materials for Silica Sand in Abrasive Blasting*, sand substitutes give off toxins "in a higher geometric mean concentration of the agent than that of silica sand".

This raises an important question: Are substitute abrasives actually less harmful than sand?

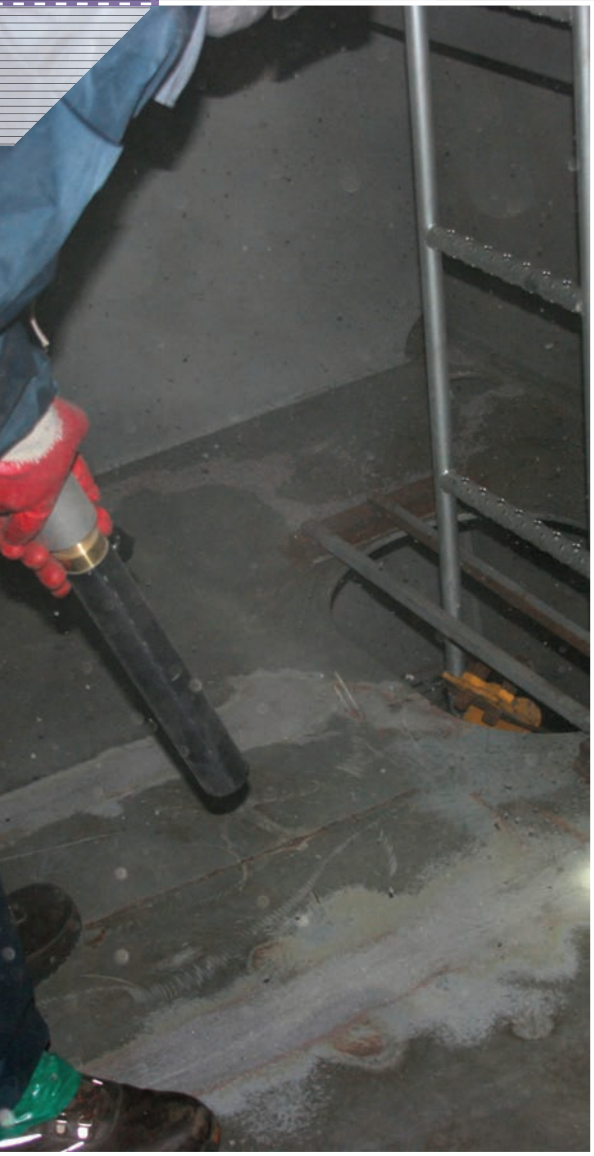
Chronic beryllium disease

In January 2012, the US consumer advocacy group Public Citizen filed a petition with the Occupational Safety and Health Administration (OSHA) citing deaths of blast workers, using coal slag as an abrasive media, who were exposed to excessively high rates of beryllium. The hard, grayish metal beryllium naturally occurs in coal and has been shown to cause lung cancer and chronic beryllium disease, a debilitating lung condition.

"Dozens of blasting workers die each year from beryllium exposure," the petition states. "OSHA's enforcement staff have known about this issue for several months, and we are calling on them to do the right thing."

But beryllium is not the only toxic by-product produced by abrasive blasting with sand substitutes. The list includes aluminum, arsenic, cadmium, chromium, cobalt, crystalline silica, lead, manganese, nickel, silver, titanium, and vanadium. Each of these toxic air pollutants may be harmful or fatal when breathed, and have been linked to specific ailments.

The OSHA findings are supported by the *Evaluation of Substitute Materials for Silica Sand in Abrasive Blasting* report, which concludes that while two studied substitute



LEFT: **Low Dust Composite Abrasive Blasting in Ballast Tank**

abrasives were less toxic than sand, the remainder were either more toxic or equally toxic.

Yet toxins created by sand substitutes are not the only shipyard hazardous air pollutants (HAPs) created by blasting. Airborne constituents from the blast process include those from substrates, old coatings, and surface contaminants. Steel, aluminum, stainless steel, galvanized steel, copper-nickel, other substrates, and old coatings may release aluminum, cadmium, chromium, copper, iron, lead, manganese, nickel, and zinc into the atmosphere, according to *Abrasive Blasting Hazards in Shipyard Employment*.

Surface coatings (some of which contain silica) including primers, anti-corrosive, and anti-fouling paints, may release copper, barium, cadmium, chromium, lead, and tributyl tin, the report stated. The roster of potential toxins lurking in or atop substrates even includes silica sand from previous blast operations.

"This means employees can have exposures to multiple air contaminants from both the abrasive and the surface being blasted," the report states.

PPE 'a last resort'

Shipyards rely heavily upon PPE to safeguard abrasive blast crews. And while there's no denying that well-maintained, properly fitted, supplied-air respirators being fed pure air from clean sources at proper pressures do a good job protecting the worker with the blast nozzle in hand, many safety experts believe PPE should be regarded strictly as a last line of defense against HAPs.

One reason is that in order to function properly, supplied-air respirators require levels of attention and maintenance not always achieved on job sites. Another is that supplied-air respirators only benefit those actually wearing them. It is not uncommon to see workers adjacent to blast operations wearing half masks, quarter masks, disposable paper masks, or no PPE whatsoever.

According to Queensland, Australia's, Abrasive Blasting Code of Practice, a hierarchy exists that ranks ways to minimize potential health issues. The best possible way (of elimination) eradicates a hazard by removing the associated risk. The second best (substitution) replaces a substance or a process with one that has less potential to cause injury.

The next best solution (isolation/engineering) changes the work environment or process to interrupt the path between the worker and the risk. The penultimate solution (administration) reduces risk by upgrading training, changing rosters, or other administrative actions. The least desirable option (PPE) should be used only "if risk cannot be reduced in any other way, as a last resort".

This hierarchy is echoed in *Abrasive Blasting Hazards in Shipyard Employment* and in OHSA standards 29 CFR (Part 1915 applies to shipyards), which states: "In the control of those occupational diseases caused by breathing air contaminated with harmful dusts, fogs, fumes, mists, gases, smokes, sprays, or vapors, the primary objective shall be to prevent atmospheric contamination."

However, in the face of mounting evidence that harmful and sometimes deadly airborne toxins are being released by sand substitutes, coatings, and substrates, the industry still leans quite heavily on the least desirable form of protection – PPE.

With the health and well-being of hundreds or thousands of yard workers, contractors, and subcontractors on the line, many shipyards, now aware of the limitations of PPE, are eliminating or drastically reducing HAPs at the source by using alternate methods of abrasive blasting that simply produce less airborne dust. If by selecting alternative blast processes airborne dust can be significantly lowered, then abrasive blasters and adjacent workers will be less reliant on PPE.

Knockdown dust

Popular commercial alternatives to conventional abrasive blasting include wet abrasive blasting, high- and ultra-high pressure water jetting, centrifugal wheel blasting, vacuum blasting, and composite abrasive blasting. The US Army Corps of Engineers *Engineer and Design Manual EM 1110–2-3400, (Painting New Construction and Maintenance)* provides an overview (dry ice blasting, chemical stripping, and

> **OSHA's staff have known about this issue for several months, and we are calling on them to do the right thing**
> **Robert Weissman,** Public Citizen Advocacy Group

mechanical stripping excluded due to editorial space constraints).

Wet abrasive blast systems work by forcefully projecting a mixture of abrasive and water onto a surface, or by shrouding a dry abrasive blast nozzle with a curtain of water. Wet abrasive blasting substantially lowers dust emissions and can produce an anchor profile. Wet abrasive blasting is not suitable for use near sensitive machinery, may require the use of additives to inhibit flash rust and generally produces a liquid waste stream that requires special handling.

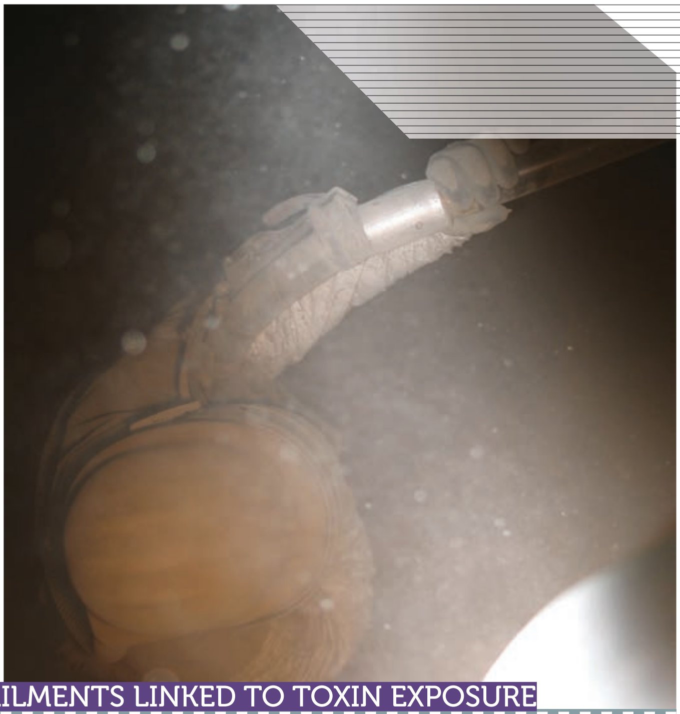
High- and ultra-high pressure water jet systems rely on engine-driven, high-pressure pumps (in the approximate range of 350-3,500 bar or 5,000-50,000psi) to propel large volumes of water onto surfaces to be cleaned. Water jetting systems substantially lower dust emissions. They may be fitted with recirculation systems that automatically remove paint chips or stripped materials from the water. Inhibitors may need to be used to prevent flash. Water jetting does not produce a significant anchor profile.

Centrifugal wheel blast systems employ high-speed rotating blades inside enclosures equipped with dust collector to propel abrasives against the surface to be cleaned. Because blasting occurs within an enclosure, there is little operator contact with airborne dust.

Centrifugal wheel blasting is employed primarily where the rotating wheel assembly remains fixed and the surface to be cleaned is passed through the enclosure. But in the field, centrifugal wheel blasting systems may be outfitted to work on large, flat horizontal surfaces such as ship decks or uniform vertical surfaces such as storage tanks. Centrifugal wheel blasting systems can create an anchor pattern.

Vacuum blast systems comprise a standard abrasive blast nozzle that operates inside a shroud that seals tightly against the work surface. Capture and collection systems recover spent abrasive and coatings. Vacuum blasting may produce an anchor profile. Interchangeable heads provide tight seals while working on inside or outside corners and flat surfaces. But in practice, instead of changing heads to clean odd shapes and irregular surfaces, operators tend to lift the somewhat awkward assemblies from the surface, defeating the vacuum and creating HAPs.

Composite abrasive blast systems employ various combinations of abrasives that have been encapsulated within a non-toxic, non-hazardous urethane sponge material to suppress dust at the source. The pliant sponge material flattens on impact, which exposes the abrasive and entraps more than 90% of what would have become HAPs. Composite abrasive blasting is similar to open nozzle blasting so operators can easily adjust to the process. Composite abrasive blasting can remove mill scale and create specific anchor profiles typically required to meet specifications. The media is recyclable. Conventional abrasive blasting remains the least expensive and most effective means of cleaning, removing coatings, and creating surface-profile anchor patterns specified by coatings manufacturers. But with knowledge that abrasive blasting with sand substitutes produces dangerous and potentially lethal levels of airborne contaminants, and that PPE may not adequately protect blast crews, adjacent workers, or shipyard neighbors from harmful and sometimes fatal airborne toxins, the trend is to reduce or eliminate HAPs at the source by using alternatives to conventional abrasive blasting.\\



RIGHT: **Dust from conventional abrasive blasting**

OSHA REPORT: AILMENTS LINKED TO TOXIN EXPOSURE

Aluminum: Respiratory inflammation
Arsenic: Skin, lung, and lymphatic cancers
Barium: Respiratory inflammation
Beryllium: Lung cancer and chronic beryllium disease, a debilitating lung condition
Cadmium: Kidney disease, pulmonary fibrosis, and emphysema, lung, and prostate cancer
Chromium (metal, trivalent, hexavalent): Skin irritation, lung disease, asthma, sinus damage
Cobalt: Chronic lung inflammation or cancer, pulmonary fibrosis, allergic dermatitis
Copper: Respiratory inflammation
Lead: Peripheral neuropathy, kidney failure, infertility, cancer
Manganese: Parkinson's disease-like movement disorder
Nickel: Lung and nasal cancers, asthma, allergic dermatitis
Silver: Gray pigmentation disorder of skin and eyes
Tin: Headaches and neurological disturbances
Titanium: Lung inflammation and pulmonary fibrosis
Vanadium: Lung inflammation, chronic bronchitis, pulmonary fibrosis
Zinc: Acute pneumonia-like symptoms

(From *Abrasive Blasting Hazards in Shipyard Employment*)

About the author

Jack Innis has written articles on coatings and coatings removal for trade publications for more than 10 years. He is a NACE-certified, level one coatings inspector.