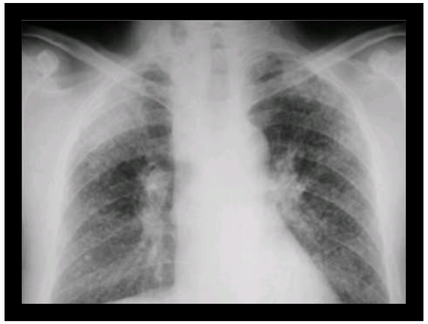
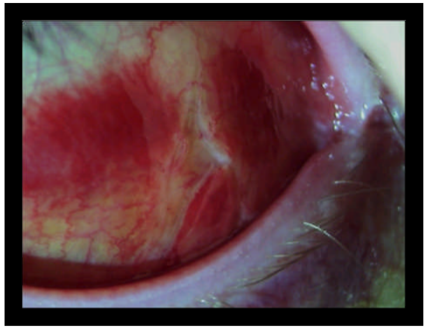
Health and Environmental Effects of Abrasive Blasting

Abrasive Selection Can Have a Widespread Impact on Health, Safety and the Environment

Disposal Volume



Hazardous Air Pollutants



Ricochet / Rebound

Staging/Containment

Environment

Weight / Transport

Health and Safety Regulatory Entities create and enforce regulations… (as example in US)**.**

National Institute for Occupational Safety and Health NIOSH

Conducts research and makes recommendations for the prevention of work-place injury and illness

OSHA® Occupational Safety and Health Administration www.osha.gov

Sets and enforces standards to ensure safe and healthful working conditions

These agencies are now finding that while sand blasting is harmful, many of the alternatives now being used are either ***as harmful*** or ***more harmful*** when compared to blasting with sand.

Timeline for Healthier Abrasive Blasting

Time line of abrasive blasting, health-related regulations…

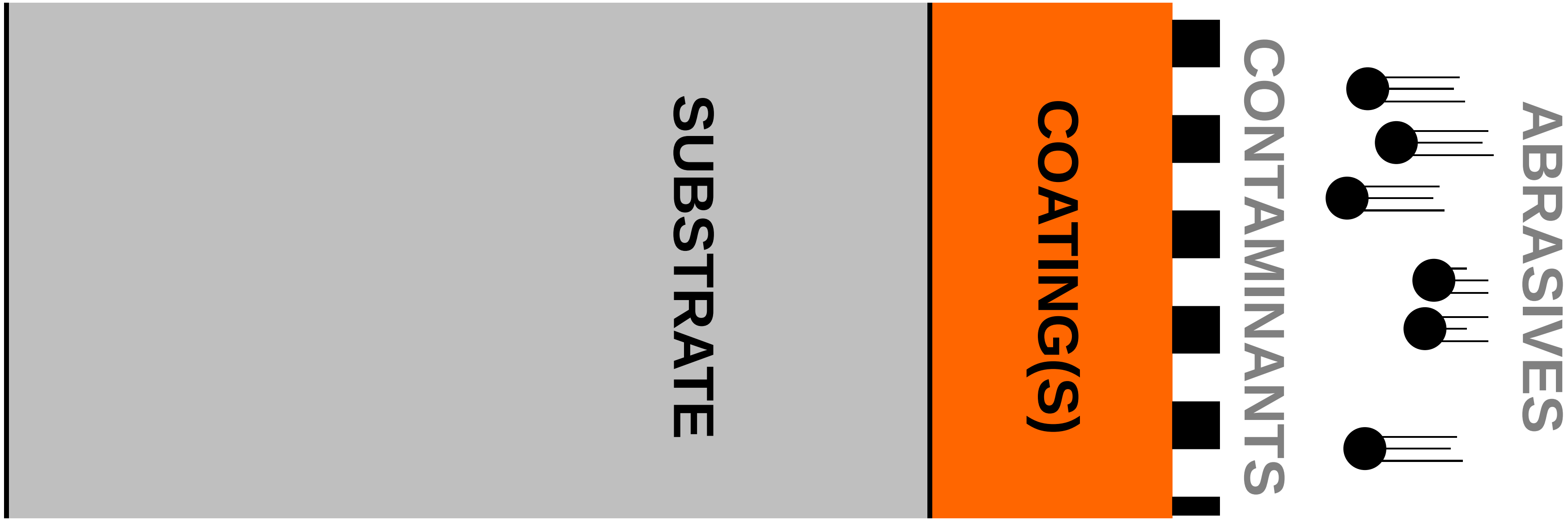
- **1947** - the United Kingdom bans use of silica sand for abrasive blasting material; Germany, Sweden, Belgium and other countries soon follow.
- **By 2002** - "Materials containing more than 1% crystalline silica for abrasive blasting is prohibited in all Victorian workplaces." Identified substitute abrasives include: garnet, crushed glass, glass bead, metal shot, steel grit, aluminum oxide and granulated plastic.
- **2006-2007** - Evidence Package organized by NIOSH's Respiratory Diseases Research Program (RDRP) found that…
  - "Specular hematite [aka barshot] and steel grit were less toxic than sand"
  - "coal, slag and olivine were more toxic [than sand]"
  - "garnet, staurolite, nickel slag, copper slag, crushed glass, and treated sand exhibited toxicity in the same range as sand"

Question: Are substitute abrasives just as harmful as sand?

SPONGE-JET

Where do Hazardous Air Pollutants (HAPS) Come From?

Abrasive Blasting Constituents: (1) Substrate, (2) Coating(s), (3) Surface Contaminants and (4) Abrasives



- Abrasive blasting constituents can become airborne during abrasive blasting.
- Depending on particle size, they can remain suspended airborne long after abrasive blasting; certain sized particles remain suspended indefinitely.
- Particles under 10 microns in diameter (PM-10 materials) when inhaled, can be easily absorbed in the blood stream.
- Of all 187 HAPS, more than 10 are associated with abrasive blasting. *(US EPA)*

Why Control Hazardous Air Pollutants (HAPS)?

Example: in a shipyard abrasive blasting environment, HAPS are found in nearly all abrasive blasting constituents.

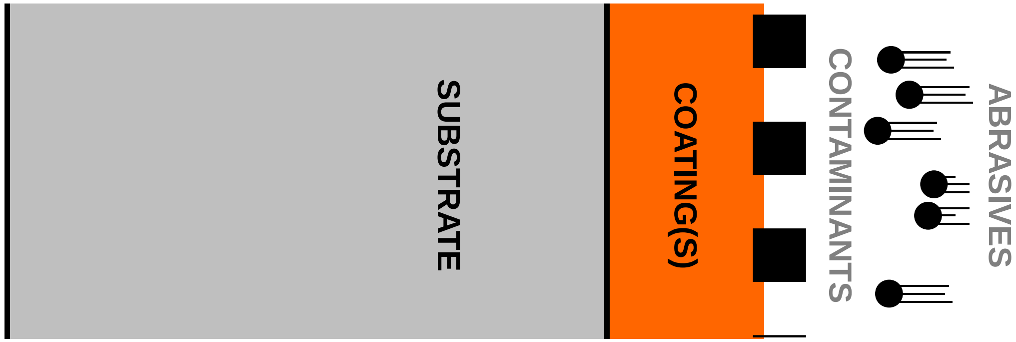


Table 1. Potential Air Contaminants Associated with Abrasive Blasting in Shipyards	
Source	**Potential Air Contaminants**
Base Material (e.g., steel, aluminum, stainless steel, galvanized steel, copper-nickel and other copper alloys)	Aluminum, cadmium, chromium, copper, iron, lead, manganese, nickel, and zinc
Surface Coatings (e.g., pre-construction primers, anticorrosive and antifouling paints)	Copper, barium, cadmium, chromium, lead, tributyl tin compounds, zinc
Abrasive Blasting Media (e.g., coal slag, copper slag, nickel slag, glass, steel grit, garnet, silica sand)	Arsenic, beryllium, amorphous silica, cadmium, chromium, cobalt, crystalline silica, lead, manganese, nickel, silver, titanium, and vanadium
Sources: EPA, 1997; EPA, 2000; NFESC, 1996; NIOSH, 1998.	

Why Control Hazardous Air Pollutants (HAPS)

Exposure to certain abrasive blasting generated HAPS and their potential effect on human:

SUBSTANCE	EFFECT
Arsenic	Skin, Lung, Lymphatic Cancer
Beryllium	Immune-Mediated Lung Disorder, Lung Cancer
Cadmium	Kidney Disease, Lung and Prostate Cancer
Chromium (IV) (hexavalent)	Lung Cancer, Asthma
Cobalt	Pulmonary Fibrosis, Lung Cancer
Lead	Clinical Peripheral Neuropathy, Cancer
Nickel	Lung and Nasal Cancer

Hazardous Air Pollutants

Abrasive blasting health issues are often overlooked and can fall between different business functions because of what isn't seen at the job site.

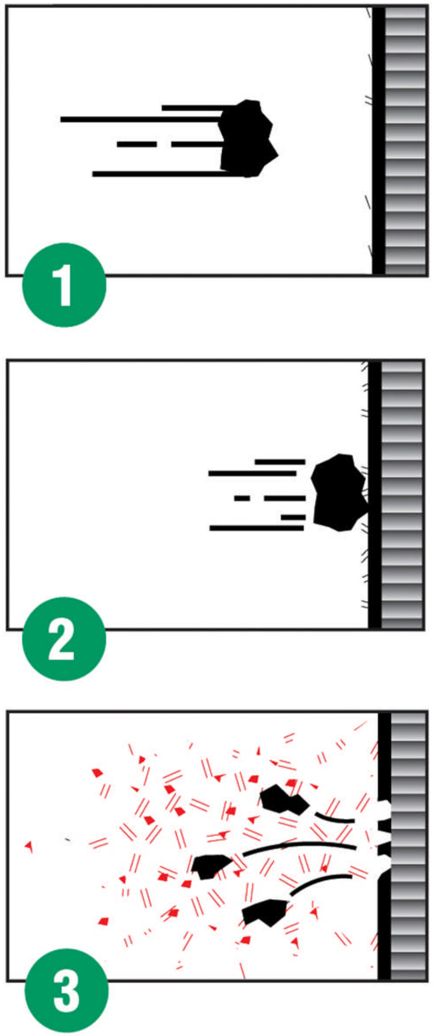
CONTRACTOR:	FACILITY MANAGERS:	INDUSTRIAL HYGENISTS
Concern for operator safety, project scheduling, satisfying specification and completing project.	Concern for employee welfare; maintaining productivity and conforming to health and safety regulations.	Concern for maintaining safe and healthy work environment. - Short-term and Long-term health of workers. - Reducing workplace liability.

Health and Environmental Effects of Abrasive Blasting

- **High-velocity abrasive rebound can cost:**
  - Operator injuries
  - Fatigue – effecting productivity
  - Damage to critical containment/equipment

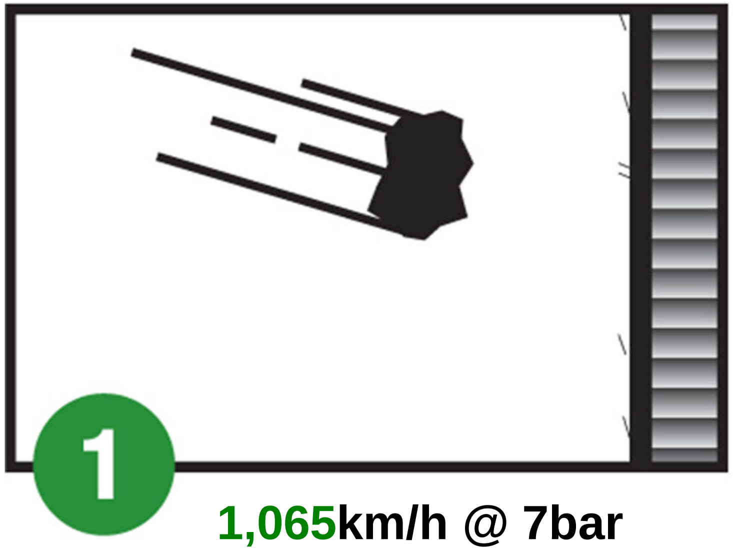
- **Most conventional abrasives dissipate little rebound energy** because they are crystalline in particle structure

- These abrasives hit the surface and either…
  - Rebound at close to initial impact speed
  - Shatter (causing excessive dust)
  - Both

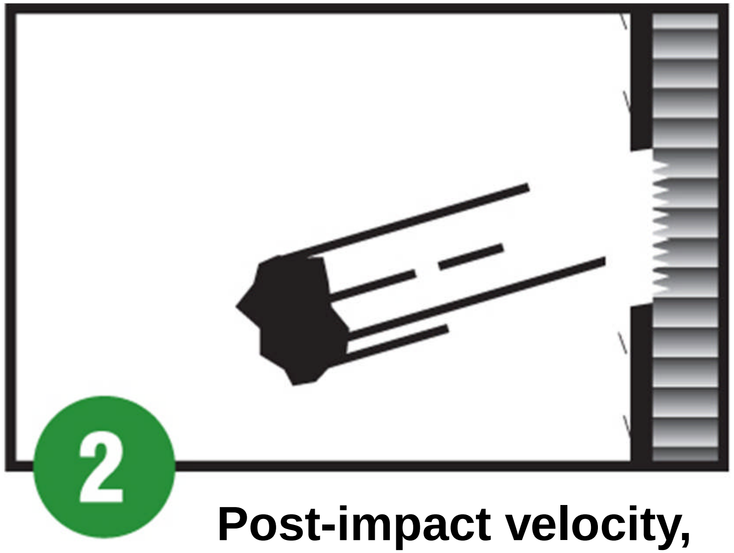


Health and Environmental Effects of Abrasive Blasting

(1) Initial strike velocity and (2) Rebound velocity for conventional (crystalline) abrasive particles



1,065km/h @ 7bar (660mph @100psi)

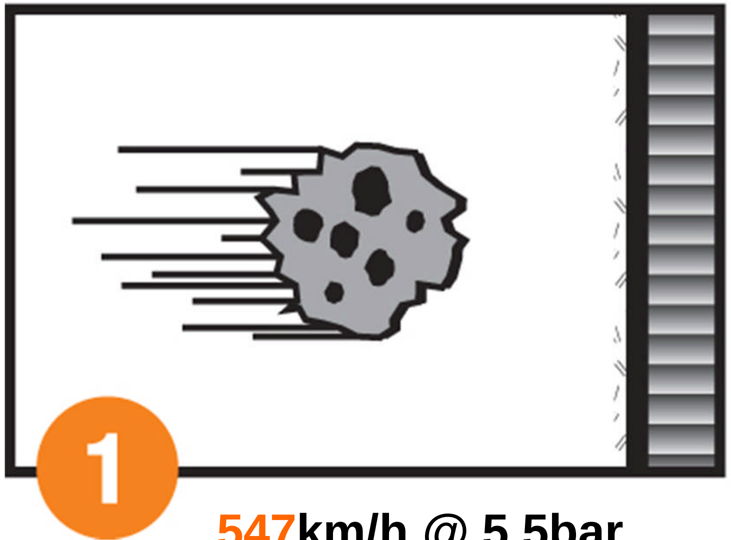


Post-impact velocity, nearly the same
(for abrasives that do not shatter)

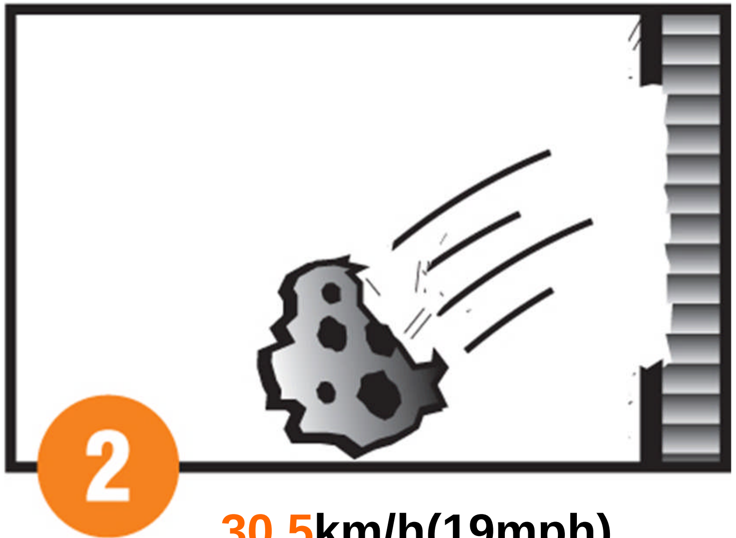
Crystalline abrasives hit the surface with very little dissipation of collision energy; they leave the surface and can strike operators, surrounding workers and/or critical containment at near initial impact speeds causing injury or damage.

Health and Environmental Effects of Abrasive Blasting

(1) Initial strike velocity and (2) Rebound velocity for composite abrasive particles



547km/h @ 5.5bar (340mph @ 80psi)



30.5km/h(19mph)

94% Reduction in Rebound Speed

Composite abrasives hit the surface and flatten, providing longer dwell time and sizable dissipation of collision energy, leaving the surface at much lower speeds.

US Depart of Transportation (DOT), Lead-Based Paint Exposure Testing on Interstate Bridge

Dust Suppression; exposure during abrasive blasting equals exposure to HAPS.

TEST (third-party): Measure airborne exposure during removal of lead-based paint on steel at US Depart of Transportation (DOT) Bridge; comparing the use of sand and composite abrasive steel grit and composite abrasive with aluminum oxide.

RESULTS: G-40 composite abrasive blasting reduced exposure to the air monitor, the blaster and the vacuum attendant **by 91.5%, 93% and 46%**, while **30-Grit aluminum oxide composite abrasive blasting reduced** (area monitor and blaster) exposure by **95% and 68%** respectively.*

	Sponge-Jet with G-40 Steel Grit	Sponge-Jet with 30-Grit Aluminum Oxide	Silica Sand
Area Monitor	950	580	11,300
Blaster	4,990	22,500	69,800
Vacuum Attendant	1,420	*no data; sample pump failure during testing	2,630

80% Average Reduction of Exposure with Composite Abrasives

Density of Abrasive Alternatives

Not all Abrasives Carry the Same Weight

Abrasive	Density Per kg/m³ (lb/ft³)	% Heavier than Composite Abrasives
Silica Sand	484(100)	73%
Mineral Slag	420-549 (85-112)	69% - 76%
Steel Grit	1,119 (230)	89%
Steel Shot	1,367 (280)	91%
Aluminum Oxide	613 (125)	80%
One Composite Abrasive *(Silver 30 Sponge Media)*	291 (27)	n/a

Injuries Related to Abrasive Blasting

Moving Heavy Objects Like Abrasives Can Cost You

Example: Cost of shipyard injuries related to stresses caused by carrying (and the manipulation) of heavy objects.

Direct Injury Costs for Musculoskeletal Injuries (medical + indemnity) by Part of Body.

Based on analysis of available participating shipyard compensation according to the US NIOSH

Ankle(s)	$2,390
Arm(s), unspecified	$7,725
Back	$6,996
Elbow(s)	$4,691
Fingers	$735
Hand(s)	$6,857
Knee(s)	$7,472
Leg(s), unspecified	$849
Neck	$5,961
Shoulder(s)	$4,960
Wrist(s)	$3,925
Mean Musculoskeletal Injury Cost = $5,523	

Injuries Related to Abrasive Blasting

Bring Safety to New Heights

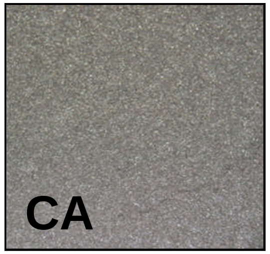
• Scaffolding requirements for low-density abrasives (e.g. composite abrasives) can change compared to high-density abrasives (e.g. conventional abrasives)
• Lighter loads create less stress and can improve performance of scaffolding.

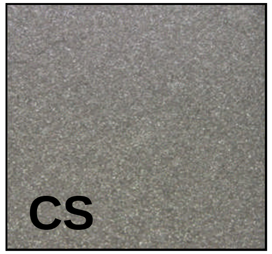
Ultra-light but effective scaffolding on platform flare allows coating maintenance never before achievable.

Costly, heavy-duty scaffolding can be necessary for high-density abrasives.

Abrasive Choice can Have a Widespread Impact on Health, Safety and the Environment

Example project removing industrial coating system from carbon steel, profiling then preparing to an Sa3 / SSPC SP-5 / NACE 1 “White Metal Blast Cleaning” cleanliness level.





	Composite Abrasive (CA)	Coal Slag (CS)
Area Prepared	.09m² (1ft²)	.09m² (1ft²)
Abrasive Weight	3.6kg (8lb)	4.5kg (10lb)
Abrasive Reuses	8	1
Abrasive Required	.5kg(1lb)	4.5kg(10lb)

Opportunity: Reduce Abrasive Volume Requirement by 90% compared to non-recyclable conventional abrasives.

Midwest Research Institute (MRI) Study

Exposure Profiling; exposure of dust generated during abrasive blasting equals exposure of HAPS.

TEST: Measured airborne exposure for total particulate (TP) and respirable particles under 10 microns in diameter (PM-10) when blasting with composite abrasives and coal slag. Test were designed to incorporate into EPA standard test A-42).

RESULTS: "Sponge Media provides a control level essentially identical to the 95% value commonly assigned to fabric filtration." *- MRI Test Administrator*

Chart shows the percent reduction in emissions:

Table 3-4. Percent Reduction in Average Emission Factors for Sponge Media

Condition	Percent reduction based on coal slag		Percent reduction based on silica sand	
	TP	PM-10	TP	PM-10
Virgin	94	97	96	99
10th Use/Mix	91	93	94	96

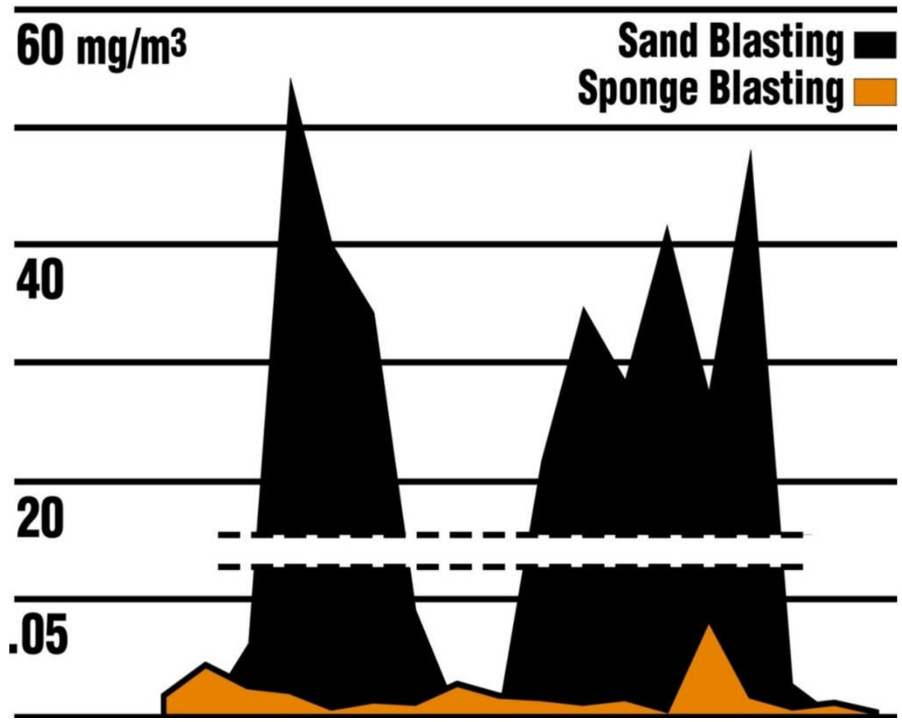
Using Sponge Media with no protection is nearly identical to using coal slag or silica sand with fabric containment protection.

Airborne Contaminant Comparison Test

Fugitive Emissions; exposure of dust generated during abrasive blasting equals exposure of HAPS.

TEST: Conducted between coal slag and composite abrasive to determine the amount of airborne dust generated by each process.

RESULTS: Sampling data revealed that conventional coal slag blasting generated up to 5,500 times more dust than composite abrasive blasting.



Coal slag blasting generated up to 5,500 times more dust than composite abrasive blasting.

Dramatically Reduce Airborne Emissions

Composite Abrasive Blasting | **Ordinary Abrasive Blasting**

Sponge Blasting can reduce dust levels drastically, increasing visibility, enhancing operator safety.

Injuries from Falls

Hazards Exist in Situations When Abrasive Blasters are Required to Work on Scaffolding:

For example:

- Surges from drops in pressure in the hose line.
- Shocks from static electricity build-up.
- Blasting hoods and excessive dust in confined containment areas can restrict operator vision
- When working from scaffolding, less weight requires less structural stabilization.

Low-density abrasives weigh considerably less per cubic unit than high-density abrasives.

Opportunity: Enhance worker safety and simplistic scaffolding requirements may exist when using low density-abrasives like composite abrasives.