Respiratory Hazards in Abrasive Blasting

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1. Abrasive Blasting Introduction
2. Types of Media
3. Types of Potential Hazards
4. Respiratory Hazards
5. Respiratory System
6. Particulate deposition
7. Occupation Exposure Limits (OEL)
8. IH Hierarchy of Control
9. Types of Respiratory PPE
10. Respiratory Protection Program
11. Conclusions
Abrasive Blasting

*The use of abrasive material surface cleaning, removal or preparation of a material

- Energy transfer using:
  - Air pressure
  - Centrifugal wheels
  - Water pressure
    - Wet blasting
    - Hydroblasting
- Equipment depends upon:
  - Specific application
  - Type(s) of abrasive(s)
    - e.g. “Sand Blasting”
Abrasive Blasting
Media Examples

NIOSH does not recommend use of sand containing >1% crystalline silica
Potential Hazards

• General Construction
  – Slips/trips
  – Falls (elevated locations)
  – Noise
  – Foot protection

• Physical
  – Temperature extremes
  – Ergonomic
  – Dermal

• Respiratory Hazards
Respiratory Hazards

- Particulate Matter (PM)
  - General
  - Particle size
  - Particle composition
- Confined Space
  - Oxygen ($O_2$) deficiency
  - Potential Toxicity
- Carbon Monoxide (CO)
### Sources of Potential Air Contaminants

<table>
<thead>
<tr>
<th>Category</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Base Material</strong></td>
<td>- e.g., steel, aluminum, stainless steel, galvanized steel, copper-nickel and other copper alloys</td>
</tr>
<tr>
<td><strong>Surface Coatings</strong></td>
<td>- e.g., pre-construction primers, anticorrosive and antifouling paints</td>
</tr>
<tr>
<td><strong>Abrasive Blasting Media</strong></td>
<td>- e.g., coal slag, copper slag, nickel slag, glass, steel grit, garnet, silica sand</td>
</tr>
</tbody>
</table>
## Example Surface Coating Concentrations

<table>
<thead>
<tr>
<th></th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Samples</td>
<td>4</td>
<td>11</td>
<td>4</td>
</tr>
<tr>
<td>Silica, crystalline</td>
<td>63,000</td>
<td>95,800</td>
<td>59,000</td>
</tr>
<tr>
<td>Arsenic</td>
<td>27.7</td>
<td>&lt;23</td>
<td>&lt;22</td>
</tr>
<tr>
<td>Beryllium</td>
<td>&lt;0.44</td>
<td>&lt;1.20</td>
<td>&lt;0.89</td>
</tr>
<tr>
<td>Cadmium</td>
<td>7</td>
<td>3.58</td>
<td>1.16</td>
</tr>
<tr>
<td>Chromium</td>
<td>1,780</td>
<td>4,080</td>
<td>4,850</td>
</tr>
<tr>
<td>Chromium (VI)</td>
<td>0.36</td>
<td>7.36</td>
<td>3.39</td>
</tr>
<tr>
<td>Lead</td>
<td>135,000</td>
<td>172,000</td>
<td>175,000</td>
</tr>
<tr>
<td>Manganese</td>
<td>692</td>
<td>237</td>
<td>243</td>
</tr>
<tr>
<td>Nickel</td>
<td>48</td>
<td>14.5</td>
<td>10.6</td>
</tr>
<tr>
<td>Silver</td>
<td>&lt;2.20</td>
<td>&lt;6.3</td>
<td>&lt;4.40</td>
</tr>
<tr>
<td>Titanium</td>
<td>128</td>
<td>64.6</td>
<td>558</td>
</tr>
<tr>
<td>Vanadium</td>
<td>8.56</td>
<td>9.95</td>
<td>10.7</td>
</tr>
</tbody>
</table>

*All results are in ppm*

Other potential components of concern:
Al, Ba, Co, Cu, Fe, Mg, Mo, P, Se, Na, Te, Ti, Y, Zn, Zr
The Human Respiratory System

Safety in Abrasive Blasting: March 27, 2013
PM Particle Size Ranges

"RESPIRABLE PARTICULATE" (RP)

Safety in Abrasive Blasting: March 27, 2013
Particle Deposition in Respiratory System

### Particle Size Deposited Deposition Mechanism(s)

- **5-100 µm**
  - Impaction
  - Head Airways Region / Nasopharyngeal Region
    - Nose
    - Nasal turbinates
    - Throat
  - Thoracic Region / Bronchial Region
    - Trachea
    - Bronchi
- **1-10 µm**
  - Sedimentation
  - Interception
  - Impaction
- **0.01-10 µm**
  - Diffusion
  - Alveolar Region / Gas Exchange Region
    - Terminal broncholi
    - Alveoli

### Air Directional Change
- Very Abrupt
- Less Abrupt
- Slow
- Very Slow

### Air Velocity
- ++++
- +++
- ++
- +
- 0
US Regulatory Issues

3 Primary OSHA Standards:
2. Maritime (29 CFR 1915)
3. Construction (29 CFR 1926)

Other Examples:
- US EPA Regulations at 40 CFR
- State & Local Regulations & Codes
Factor of 300000 between TP and Be OELs
Determining Hazard Potential

- **MSDS (now SDS)**
  - Carcinogens listed (for >0.1% by weight)
  - ACGIH TLV also required to be listed
  - Respiratory protection

- **Chemical Analysis:**
  - Media
  - Coating
  - Substrate

- **Scientific Literature**
  - Journals
  - Government Agency Publications
Pneumoconioses

• A group of interstitial lung diseases that are caused by the inhalation of a range of organic and non-organic dusts/fumes which are then retained in the lungs. The disease is a result of the lung tissue’s reaction to the dust.

• The principal cause of the pneumoconioses is work-place exposure

• Singular= Pneumoconiosis
Respirable Particulate Sampling Results

• 2013 Ceballos et al. JOEH
  – 100% of analyzable RP samples exceed PEL (5 mg/m³)
  – Measured concentrations 75-25000 mg/m³

• 2006 Meeker et al. JOEH
  – 100% of RP samples exceeded PEL
  – Measured concentrations 30-5652 mg/m³
IH Hierarchy for Addressing Hazards

- **Engineering Control examples**
  - Material substitution
  - Enclosures
  - Remote or automated blasting
  - LEV
- **Administrative Control examples**
  - Restrictions on work time
  - Confined spaces entry protocols
- **PPE**
Respiratory PPE

1. If controls not feasible
2. Oxygen Deficient Atmosphere

Respiratory PPE:
- Properly selected based on task
- Individually fitted
- Properly maintained
Do I need to wear a respirator?

- What is the hazard?
- What is the degree of the hazard
  - What is expected range of concentrations?
  - What is relevant OEL?
- Work requirements
- The user
Types of Respirators

• Air Purifying Respirator (APR)
  – Non-powered APR
  – Powered Air Purifying Respiratory (PAPR)

• Atmosphere Supplying
  – Supplied Air Respirator (SAR)
  – Self Contained Breathing Apparatus (SCBA)
  – Combination

Also: Positive Pressure vs. Negative Pressure
APR/PAPR Examples
• APFs and Maximum Use Concentrations (MUCs).

See: 29 CFR 1910.134
## Assigned Protection Factors (APF)

<table>
<thead>
<tr>
<th>Type of Respirator¹,²</th>
<th>Quarter mask</th>
<th>Half mask</th>
<th>Full facepiece</th>
<th>Helmet/Hood</th>
<th>Loose-fitting facepiece</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Air-Purifying Respirator</td>
<td>5</td>
<td>10</td>
<td>50</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>2. Powered Air-Purifying Respirator (PAPR)</td>
<td>—</td>
<td>50</td>
<td>1,000</td>
<td>25/1,000⁴</td>
<td>25</td>
</tr>
<tr>
<td>3. Supplied-Air Respirator (SAR) or Airline Respirator</td>
<td>• Demand mode</td>
<td>10</td>
<td>50</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>• Continuous flow mode</td>
<td>50</td>
<td>1,000</td>
<td>25/1,000⁴</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>• Pressure-demand or other positive-pressure mode</td>
<td>50</td>
<td>1,000</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>4. Self-Contained Breathing Apparatus (SCBA)</td>
<td>• Demand mode</td>
<td>10</td>
<td>50</td>
<td>50</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>• Pressure-demand or other positive-</td>
<td>—</td>
<td>10,000</td>
<td>10,000</td>
<td>—</td>
</tr>
</tbody>
</table>
“Abrasive-blasting respirator” or “Particulate-filter respirator” (“dust-filter respirator”)

Abrasive blasting respirators = NIOSH Type CE SAR
- Required when:
  - working in enclosed or confined spaces; or
  - using abrasive media that contains more than one percent crystalline silica.

For other situations, abrasive blasters must be protected with Type CE SAR or APR with HEPA (N-100) filters.
Ablasive Blasting PPE

- Change faceshield 3-4 times daily
- Air-supplied hood: protects head, neck & shoulders
- Hearing protection
- Gloves should protect forearm
- Protective coveralls
- Safety boots
NIOSH Type CE Respirator Approvals

30 models (total) currently approved by NIOSH

Approved Vendors

• MSA
• Clemco Industries Corp.
• E.D. Bullard Company
• Avon-International Safety Instruments, Inc.
• RPB Limited
• 3M Company

Note: loose fitting Type CE Abrasive Blasting Respirators (hoods, helmets) DO NOT need to be fit tested

Source:  http://www2a.cdc.gov/drds/cel/cel_form_code.asp
Photos of CE Respirators-1
Photos of CE Respirators-2
Photos of CE Respirators-3

3M™ Whitecap™ Abrasive Blasting Helmet Assembly W-8100 and W-8100B

Safety in Abrasive Blasting: March 27, 2013
Photos of CE Respirators-4

Safety in Abrasive Blasting: March 27, 2013
Respiratory Protection Program

- OSHA 29 CFR 1910.134
  - Required whenever respirators are required to be worn
  - Written program is required
  - Additional program requirements
Elements of a Respiratory Protection Program

1. Procedures for selecting respirators
2. Medical evaluations
3. Fit testing procedures
4. Instructions on Use of respirators
5. Procedures for cleaning and maintaining respirators
6. Procedures to ensure adequate air quality/quantity
7. Training of employees in the potential respiratory hazards
8. Training of employees in the proper use of respirators
9. Procedures for regularly evaluating the effectiveness of the program.
10. Worksite Specific Procedures may be needed.

http://www.osha.gov/dts/osta/otm/otm_viii/otm_viii_2.html#4
Fit testing

• Loose fitting (hoods, helmets) Type CE Abrasive Blasting Respirators DO NOT need to be fit tested
• Tight fitting Type CE DO need to be fit tested
  – Quantitative
  – Qualitative
Examples of Improper Usage

• Facepiece seal leakage (not an issue with CE hood respirators)
• Removal of respirator at wrong time in hazardous atmosphere
• Improperly performing user seal checks
• Improperly repairing defective parts
• Improper air supply source (SAR)
• Improper air supply monitoring (SAR)
Alert: Abrasive Blaster Dies of Carbon Monoxide Poisoning

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Content last reviewed: January 2011

Proper maintenance and use of compressor might have prevented this death

Hazard Summary:
A 43-year old, self-employed male sandblaster died of carbon monoxide poisoning at his outdoor work station.

Laborer Dies of Carbon Monoxide Poisoning During Sandblasting Operations in Virginia

SUMMARY
A 46-year-old male laborer at an antique dealership was overcome by carbon monoxide while sandblasting wrought iron chairs. The victim had begun sandblasting outdoors and was wearing an abrasive-blasting airline respirator. Air was supplied by a diesel-fueled air compressor which was later found to be
Grade D Breathing Air Required

- Compressed Gas Association (CGA) Specification
  Includes:
  - Air quality requirements
  - Monitoring requirements

- OSHA referenced requirement for SAR
Temperature related issues

• Heat related illnesses of bigger concern in USA
• Emergency first aid training
• Prevention
  – Rest periods
  – Hydration
  – Fitness
  – Acclimatization
  – Climate control
Proper maintenance

• Quick pre-use inspection
  – By person using respirator

• Clean between use
  – Keep visibly cleaned
  – Wet cleaning better
  – Do not use air pressure blowing
  – Take care in choosing cleaning agents
    • Water and soap
    • Methanol or isopropanol impregnated wipes
  – May require vacuuming (with HEPA filtration)
  – Performed by person wearing respirator or another properly trained & authorized person
Follow Respirator User’s Guide

- Comply with manufacturer’s instructions
  - Routine maintenance steps and frequency
  - Use only approved replacement parts
  - Performed by properly qualified individual
Conclusion

- Respiratory Hazards are due to
  - PM concentrations
  - Particle size
  - PM content

- Prevention is much better than Treatment

- PPE used only if controls not effective in reducing exposures

- APR N100 respirators of limited applicability

- Type CE respirators optimized for abrasive blasting
  - provide best combination of protection, ease of use and costs

- Respiratory Protection Program has specific required elements

- Protection from potential respiratory hazards is possible
Conclusion

• Respiratory Hazards are due to
  – PM concentrations
  – PM content
    • Media
    • Coatings
    • Substrates
• Prevention is much better than Treatment
• PPE used only if controls not effective in reducing exposures
• APR N100 respirators of limited applicability
• Type CE respirators optimized for abrasive blasting
  - Provide best combination of protection, ease of use and costs
• Respiratory Protection Program has specific required elements
• Protection is possible
Thank you for listening!

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