PRINCIPLES OF BLAST CLEANING
In the next 45 to 50 minutes..........................

- Blast cleaning - application basics
- Initial and final conditions of new steel - significance
- Types of media propulsion
- Elements of a blast cleaning machine
- Wheel parts and hot spots
- Process parameters affecting blast quality
- Operating cost elements - wheel and airblast systems
- Blast media information, its effect on cleaning and operating mix
- Introduction to shot peening - comparison with blast cleaning
### Blast Cleaning - Purpose

<table>
<thead>
<tr>
<th>BLAST CLEANING</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Purpose</strong></td>
<td>Remove rust, scale and prepare surface prior to downstream coating</td>
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<td><strong>Process Control</strong></td>
<td>Etching, De-burring &amp; other special processes</td>
</tr>
<tr>
<td><strong>Quality / Measurement</strong></td>
<td>Generally visual to standards or preference</td>
</tr>
</tbody>
</table>
What do you need to know?

Are we blast cleaning or shot peening?

What is the initial condition of the steel component?

What is the final desired outcome?

Has the part ever been shot blasted - if not, did an alternate process work?
Blast Cleaning – Impact Energy

Kinetic or Impact Energy

= \frac{1}{2} \times \text{mass of abrasive} \times \text{square of velocity}
Four grades of initial surface condition
Four grades of final finishes (defined by SSPC)

✓“A“ - Steel surface covered completely with adherent mill scale: little or no rust visible (SSPC-Vis-1 - Rust Grade A)

✓“B“ - Steel surface completely covered with both mill scale and rust (SSPC-Vis-1 - Rust Grade B)

✓“C“ - Steel surface completely covered with rust; little or no pitting visible (SSPC-Vis-1 - Rust Grade C)

✓“D“ - Steel surface completely covered with rust; pitting visible (SSPC-Vis-1 - Rust Grade D)
•“A“ - Steel surface covered completely with adherent mill scale: little or no rust visible (SSPC-Vis-1 - Rust Grade A)

•These are the TWO levels of surface preparation recognized by SSPC in (SSPC-Vis-1 - Rust Grade A):

SP 5 (White Metal)  SP 10 (Near White)

•SSPC VIS 1, Guide & Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning.
• “B” - Steel surface completely covered with both mill scale and rust (SSPC-Vis-1 - Rust Grade B)

• These are the FOUR levels of surface preparation recognized by SSPC (SSPC-Vis-1 - Rust Grade B):

  SP 5 (White Metal)  SP 10 (Near White)  SP 10 (Commercial)  SP 7 (Brush)

SSPC VIS 1, Guide & Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning.

INITIAL & FINAL CONDITIONS: RUST GRADE B
"C" - Steel surface completely covered with rust; little or not pitting visible (SSPC-Vis-89 - Rust Grade C)

These are the FOUR levels of surface preparation recognized by SSPC (SSPC-Vis-89 - Rust Grade C):

- SP 5 (White Metal)
- SP 10 (Near White)
- SP 10 (Commercial)
- SP 7 (Brush)

SSPC VIS 1, Guide & Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning.

INITIAL & FINAL CONDITIONS: RUST GRADE C
•“D“ - Steel surface completely covered with rust; pitting visible (SSPC-Vis-89 - Rust Grade D)

•These are the FOUR levels of surface preparation recognized by SSPC (SSPC-Vis-89 - Rust Grade D):

SP 5 (White Metal)  SP 10 (Near White)  SP 10 (Commercial)  SP 7 (Brush)

•SSPC VIS 1, Guide & Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning.

INITIAL & FINAL CONDITIONS: RUST GRADE D
### Why do contamination & finish requirement matter?

- Total Power Required = Speed (FPM) x width of work / factor

<table>
<thead>
<tr>
<th>Factor</th>
<th>Cleaning Quality</th>
<th>SSPC Profile</th>
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<tbody>
<tr>
<td>0.5 to 0.6 sq.ft./min./HP</td>
<td>White Metal</td>
<td>SSPC SP5</td>
</tr>
<tr>
<td>0.8 to 1.0 sq.ft./min./HP</td>
<td>Near White</td>
<td>SSPC SP10</td>
</tr>
<tr>
<td>1.5 sq.ft./min./HP</td>
<td>Commercial</td>
<td>SSPC SP6</td>
</tr>
<tr>
<td>1.8 sq.ft./min./HP</td>
<td>Brush-off</td>
<td>SSPC SP7</td>
</tr>
</tbody>
</table>
Two main types of media propulsion

**Airblast**

- Propels abrasive by centrifugal force through controlled blast pattern and direction.

- Blast media is pressurized in a blast tank and propelled through a nozzle or multiple nozzles.

**Wheelblast**

- Propels abrasive by centrifugal force through controlled blast pattern and direction.
When is Wheelblast preferred?

- Complete coverage
- Larger coverage area
- Higher Production Rates
- Compressed air constraints
- Commonality with machines
When is Airblast preferred?

- Intricate Areas
- Non-metallic media
- Holes, Slots and Bores
- Targeted areas on part
- Flexibility of stand-off distance
- Thin wall sections
- Ease of automation
Airblast and Wheelblast applications

Typical parts processed in a Wheelblast machine

Typical parts processed in an airblast machine

Typical Components: AIRBLAST & WHEELBLAST
Five Basic Elements in a Wheelblast Machine

1. **AIRLESS BLAST WHEEL**
   One or more airless blast wheels propel the abrasive by centrifugal force in a controlled pattern and direction.

2. **CABINET**
   A cabinet contains the abrasive material as the wheel performs its cleaning function.

3. **WORK HANDLING SYSTEM**
   A work handling system presents the work to be cleaned to the abrasive action of the wheel.
4. ABRASIVE CLEANING AND RECYCLING SYSTEM

An abrasive cleaning and recycling system transports, conditions and cleans the abrasive, removing contaminants and fines from the abrasive going back to the wheel.

5. DUST COLLECTOR

A dust collector removes all dust contaminants and abrasive fines from the blast machine environment for a clean and safe operating atmosphere.
COMPONENTS OF A BLAST WHEEL
Blast Pattern Test Sheet

- Tailings
- Hot Spot
- Headings
Power Requirement of Wheel and Air systems

For abrasive flow of 2100 Lbs per minute

• 21 operators
• ½” nozzles
• Compressed air consumption 350 ft³/min per nozzle
• Compressor power 1400 kW

OR

4 wheels 20 HP each
80 HP (60 KW)
Energy factor 24 !!!
Advantages:

• Velocity of shot easily controlled through wheel speed.
• High flow rate of abrasive will provide high production.
• Economical – one wheel can throw 300 lbs per minute with a 15 HP wheel equal to five 3/8” nozzles at direct pressure at 80 psi at a power requirement of 190 HP.
• Self contained unit does not require a compressor.

Disadvantages:

• Can only use metallic media.
• Can damage delicate parts.
• Not good for localized peening.
• Greater abrasive consumption.
Factors affecting the Shot Blasting process

• Initial condition of the component – material and contamination

• Velocity of abrasive

• Size (and shape) of abrasive

• Hardness of abrasive

• Blast wheel location

• Travel speed of part through the machine (cycle time / exposure time)
Follow the path of abrasive

- Regular inspection is essential
- Commonly blamed on the manufacturer
- Quality of machine manufacture (cabinet design, lining etc.) does play a role
- Common issues: leakage, noise, media consumption
- Machine designs / controls are not intuitive to prompt maintenance
- Saves on operating cost if taken seriously
Operating Cost Elements

• Primary heads - Wheelblast
  • Electricity (total connected load x cost of power)
  • Media consumption / replenishment (total media flow x breakdown rate)
  • Cost of wheel parts - wheel parts
  • Cabinet and other component wear - liners, bearings, elevator belt & buckets, dust collector cartridges etc.
  • Wear on work handling arrangement components - table, rollers, belts etc.
Operating Cost Elements

• Primary heads - Airblast
  • Electricity (total connected load x cost of power) - to operate compressor
  • Media consumption / replenishment (total media flow x breakdown rate)
  • Cost of wear parts - nozzle, hoses, tank valves etc.
  • Cabinet and other component wear - liners, bearings, elevator belt & buckets, dust collector cartridges etc.
  • Wear on work handling arrangement components - table, rollers, belts etc.
### BLAST MEDIA SIZES

<table>
<thead>
<tr>
<th>Code</th>
<th>Name</th>
<th>Min. Size</th>
<th>Max. Size</th>
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<tbody>
<tr>
<td>S780</td>
<td>All Pass No. 7 Screen</td>
<td>1.110 - 2.80</td>
<td>.0787 - 2.00</td>
</tr>
<tr>
<td>S660</td>
<td>All Pass No. 8 Screen</td>
<td>.907 - 2.36</td>
<td>.0681 - 1.70</td>
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<tr>
<td>S550</td>
<td>All Pass No. 10 Screen</td>
<td>.787 - 2.00</td>
<td>.0555 - 1.40</td>
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<tr>
<td>S460</td>
<td>All Pass No. 12 Screen</td>
<td>.681 - 1.70</td>
<td>.0489 - 1.18</td>
</tr>
<tr>
<td>S390</td>
<td>All Pass No. 14 Screen</td>
<td>.555 - 1.40</td>
<td>.0394 - 1.00</td>
</tr>
<tr>
<td>S330</td>
<td>All Pass No. 16 Screen</td>
<td>.499 - 1.18</td>
<td>.0311 - 0.850</td>
</tr>
<tr>
<td>S280</td>
<td>All Pass No. 18 Screen</td>
<td>.394 - 1.00</td>
<td>.0270 - 0.710</td>
</tr>
<tr>
<td>S230</td>
<td>All Pass No. 20 Screen</td>
<td>.331 - 0.850</td>
<td>.0234 - 0.600</td>
</tr>
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<td>S170</td>
<td>All Pass No. 22 Screen</td>
<td>.197 - 0.500</td>
<td>.0117 - 0.300</td>
</tr>
<tr>
<td>S110</td>
<td>All Pass No. 25 Screen</td>
<td>.105 - 0.425</td>
<td>.0117 - 0.300</td>
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<tr>
<td>S70</td>
<td>All Pass No. 30 Screen</td>
<td>.070 - 0.190</td>
<td>.0049 - 0.125</td>
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<tr>
<td>G10</td>
<td>All Pass No. 7 Screen</td>
<td>1.110 - 2.80</td>
<td>.0787 - 2.00</td>
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<td>All Pass No. 60 Screen</td>
<td>.117 - 0.300</td>
<td>.0049 - 0.125</td>
</tr>
</tbody>
</table>

Information courtesy: Ervin Industries
Peening Parameters - Media size, shape and type

- Most commonly used peening media
- Manufactured to AMS specifications

Source: ervinindustries.com
Media: Shot vs. Grit

1st Choice = Smallest **Effective** Shot

Flow: Volume in Pounds per Minute

1st Choice = Highest **Usable** Amount

Speed: Velocity at Blade Tip in FPS

1st Choice = Lowest **Effective** FPS
Media size and cleaning

Too small

Too big

Balanced operating mix

BLAST MEDIA SPECIFICATIONS
<table>
<thead>
<tr>
<th>Abrasive Size</th>
<th>Nominal Dimensions inches</th>
<th>Average number of pellets per pound of shot</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-70</td>
<td>0.007</td>
<td>12,000,000</td>
</tr>
<tr>
<td>S-110</td>
<td>0.0117</td>
<td>3,390,000</td>
</tr>
<tr>
<td>S-170</td>
<td>0.0165</td>
<td>1,200,000</td>
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<td>S-230</td>
<td>0.0232</td>
<td>420,000</td>
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<tr>
<td>S-280</td>
<td>0.028</td>
<td>250,000</td>
</tr>
<tr>
<td>S-330</td>
<td>0.0331</td>
<td>152,000</td>
</tr>
<tr>
<td>S-390</td>
<td>0.0394</td>
<td>93,000</td>
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<td>S-460</td>
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<td>54,000</td>
</tr>
<tr>
<td>S-550</td>
<td>0.0555</td>
<td>32,000</td>
</tr>
<tr>
<td>S-660</td>
<td>0.0661</td>
<td>19,000</td>
</tr>
<tr>
<td>S-780</td>
<td>0.0787</td>
<td>11,000</td>
</tr>
</tbody>
</table>

- For a given mass (steel shot), impact power delivered to the work varies as the square of a change in velocity.
- Weight or mass of a sphere varies as a cube of its diameter.
The profile depth (or height) is dependent on the size, type, hardness of abrasive, particle velocity and angle of impact.

### Roughness Measurements

**Rz Mean Peak-to-Valley Height**

Rz is the average of the 5 single peak-to-valley heights of five adjoining sampling lengths Ie.

**Rmax Maximum Roughness Depth**

Rmax is the largest single peak-to-valley height (Zi) within five adjoining sample lengths.

\[
R_z = \frac{(Z_1 + Z_2 + Z_3 + Z_4 + Z_5)}{5}
\]

\[
R_{\text{max}} = Z_3
\]

**Ra Mean Roughness**

Ra is the arithmetical average value of all areas of the profile from the mean line.

\[
l_e = \text{cut-off}
\]

**R\text{a}, R\text{z}, R\text{max} value depend on cut-off setting.**

ROUGHNESS MEASUREMENTS
**Cut wire**

- Blasting Applications - HRC 45-50;
- Shot Peening high strength parts HRC 55-60
- Shot Peening softer parts - HRC 50-55

Advantages:
- Improved consistency
- Highest durability
- Dust generation
- Surface contamination
- Improved part fatigue resistance

Source: premiershot.com

**Conditioned Cut Wire - Media size, shape and type**
<table>
<thead>
<tr>
<th>Purpose</th>
<th>Remove rust, scale and prepare surface prior to downstream coating</th>
<th>Induce compressive residual stress and enhance useful life</th>
</tr>
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<tbody>
<tr>
<td>Application</td>
<td>Carried out on most metallic components</td>
<td>Generally on components that undergo cyclic loading</td>
</tr>
<tr>
<td>Result</td>
<td>Enhances life of coating, cosmetic finish</td>
<td>Part of maintenance procedure</td>
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Process to increase resistance to fatigue fracture of a part that undergoes cyclic loading.

Peening intensity is measured by deflection of a piece of spring steel called ‘Almen Strip’

Almen intensity is a measurable representation of the compressive stresses induced in the peened part.

Ferrous peening media: steel shot, conditioned cut wire; Non-ferrous: glass bead and ceramic.
INTENSITY MEASUREMENT PROCEDURE
Wheel speed / Air pressure = Shot velocity = Intensity

STEP 1: Establish velocity required to reach target intensity by adjusting wheel speed or air pressure

STEP 2: Find optimal shot flow rate corresponding to wheel speed/air pressure required in step 1

STEP 3: Develop saturation curve and set intensity

STEP 4: Determine time required to achieve 98 (100%) coverage on part

STEP 5: Expose parts to shot stream to achieve % coverage requested (100%, 150% etc.)
Cleaning and Peening - Comparison

- Media velocity: No monitoring
- Media size: Inconsistency not an issue
- Media shape: Not critical
- Measurement of results: Visual only
- Monitoring of results and reporting inconsistencies: For critical etching applications only
- Measurement and monitoring required
- Consistency critical
- Consistency critical
- Need to be carried out regularly
- Specification driven
Blast Cleaning

Steel shot (carbon & stainless)
Steel grit
Zinc shot / cut wire
Shot / grit mix *(operating mix)*
Shot size mix *(operating mix)*
Non-ferrous – glass bead, ceramic, aluminum oxide
Organic – corn cob, walnut shell

Consistency of shot size and shape is not critical

Shot Peening

Steel shot
Conditioned cut wire
Glass bead
Ceramic

Consistency of shot size, shape very critical for repeatable peening results