October 2013

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

AGENDA

	BLAST CLEANING
Purpose	Remove rust, scale and prepare surface prior to downstream coating
Application	Carried out on most metallic components
Result	Enhances life of coating, cosmetic finish
Process Control	Etching, De-burring & other special processes
Quality / Measurement	Generally visual to standards or preference

Blast Cleaning - Purpose

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 - what do you need to know about the application?

Kinetic or Impact Energy

= ½ x mass of abrasive x 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)

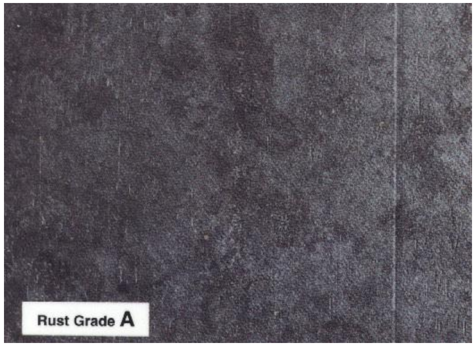
✓"B" – Steel surface completely covered with both mill scale and rust (SSPC-Vis-1 – Rust Grade B)

✓"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)

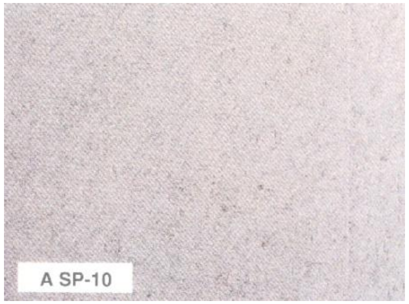
INITIAL CONDITIONS OF STEEL

•"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)

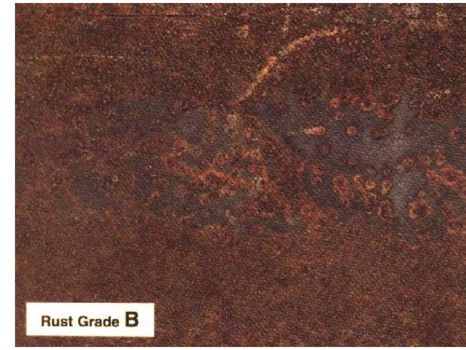


SP 10 (Near White)

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

INITIAL & FINAL CONDITIONS: RUST GRADE A

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

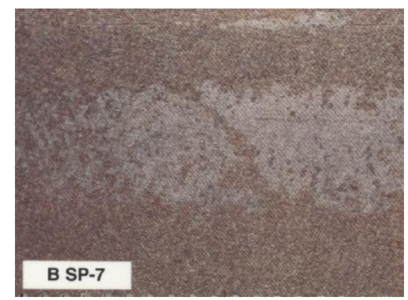


•These are the FOUR levels of surface preparation recognized by SSPC (SSPC-Vis-1 - Rust Grade B):

SP 5 (White Metal)

SP 10 (Near White)

SP 10 (Commercial)

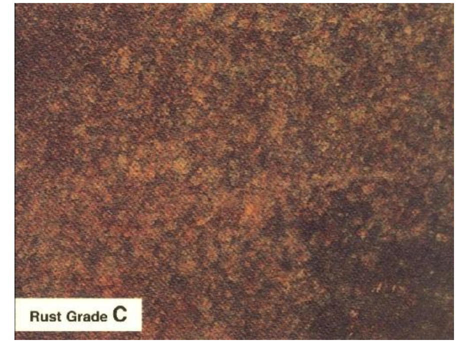


SP 7 (Brush)

•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)

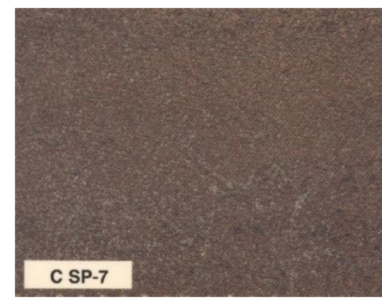


•These are the FOUR levels of surface preparation recognized by SSPC (SSPC-Vis-89 – Rust Grade C) :

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.

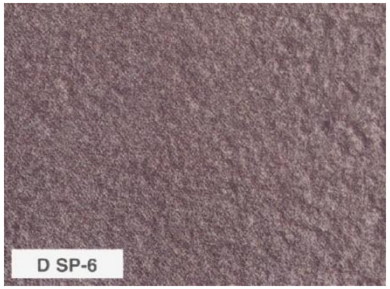
INITIAL & FINAL CONDITIONS: RUST GRADE C

•"D" – Steel surface completely covered with rust; pitting visible (SSPC-Vis-89 – Rust Grade D)

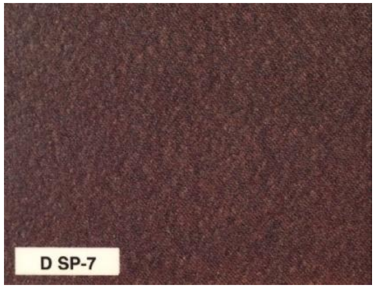
•These are the FOUR levels of surface preparation recognized by SSPC (SSPC-Vis-89 – Rust Grade D):

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

Factor	Cleaning Quality	SSPC Profile
0.5 to 0.6 sq.ft./min./HP	White Metal	SSPC SP5
0.8 to 1.0 sq.ft./min./HP	Near White	SSPC SP10
1.5 sq.ft./min./HP	Commercial	SSPC SP6
1.8 sq.ft./min./HP	Brush-off	SSPC SP7

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

Why do contamination & finish requirement matter?

Airblast

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

Propels abrasive by centrifugal force through controlled blast pattern and direction

Wheelblast

Two main types of media propulsion

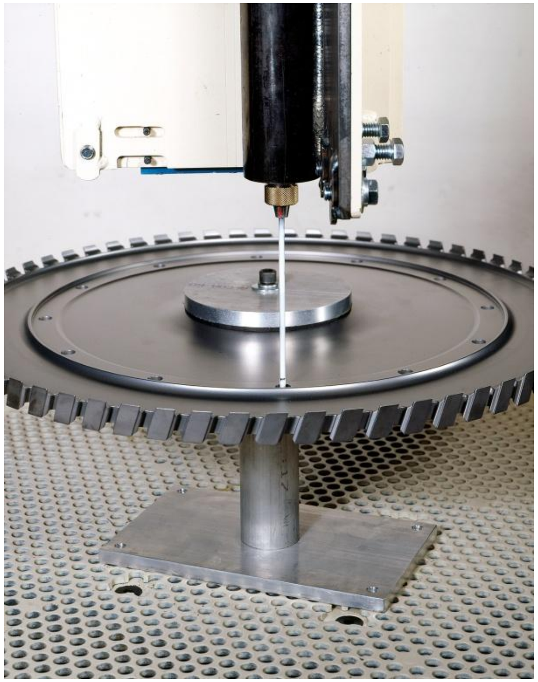
- Complete coverage
- Larger coverage area
- Higher Production Rates

Photo courtesy – Proaviation.com

- Compressed air constraints
- Commonality with machines

When is Wheelblast preferred?

- Intricate Areas
- Non-metallic media
- Holes, Slots and Bores

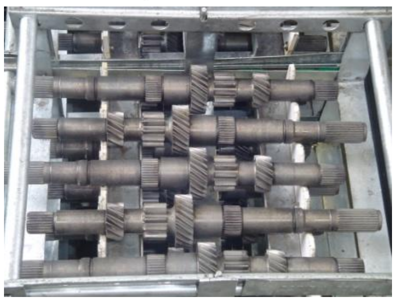


- Targeted areas on part
- Flexibility of stand-off distance
- Thin wall sections
- Ease of automation

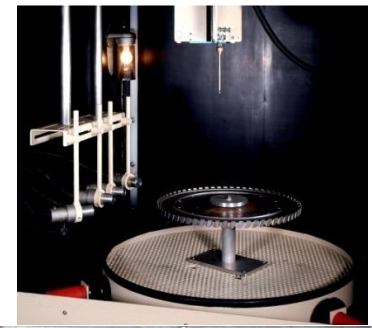
When is Airblast preferred?

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

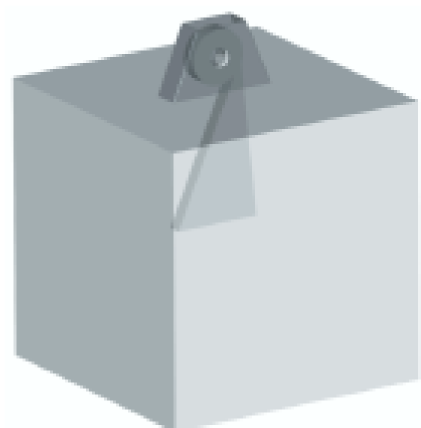
2. **CABINET**

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

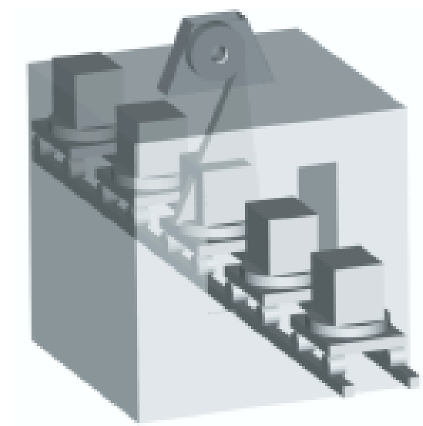
3. **WORK HANDLING SYSTEM**

   A **work handling system** presents the work to be cleaned to the abrasive action of the wheel

1. Wheel unit



2. Cabinet



3. Work handling system

Wheel Blast Machine - Elements

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

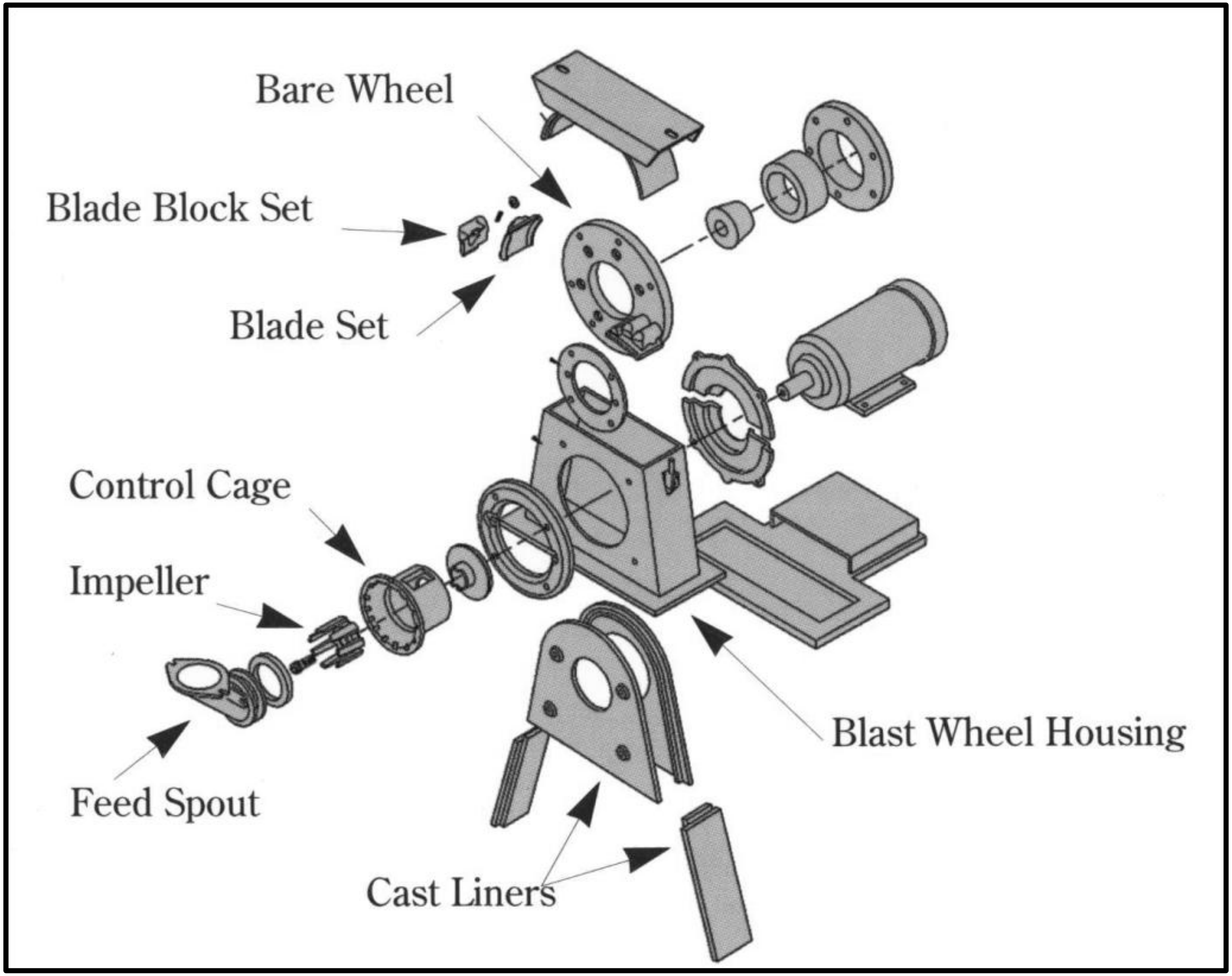
5. **DUST COLLECTOR**

A **dust collector** removes all dust contaminants and abrasive fines from the blast machine environment for a clean and safe operating atmosphere

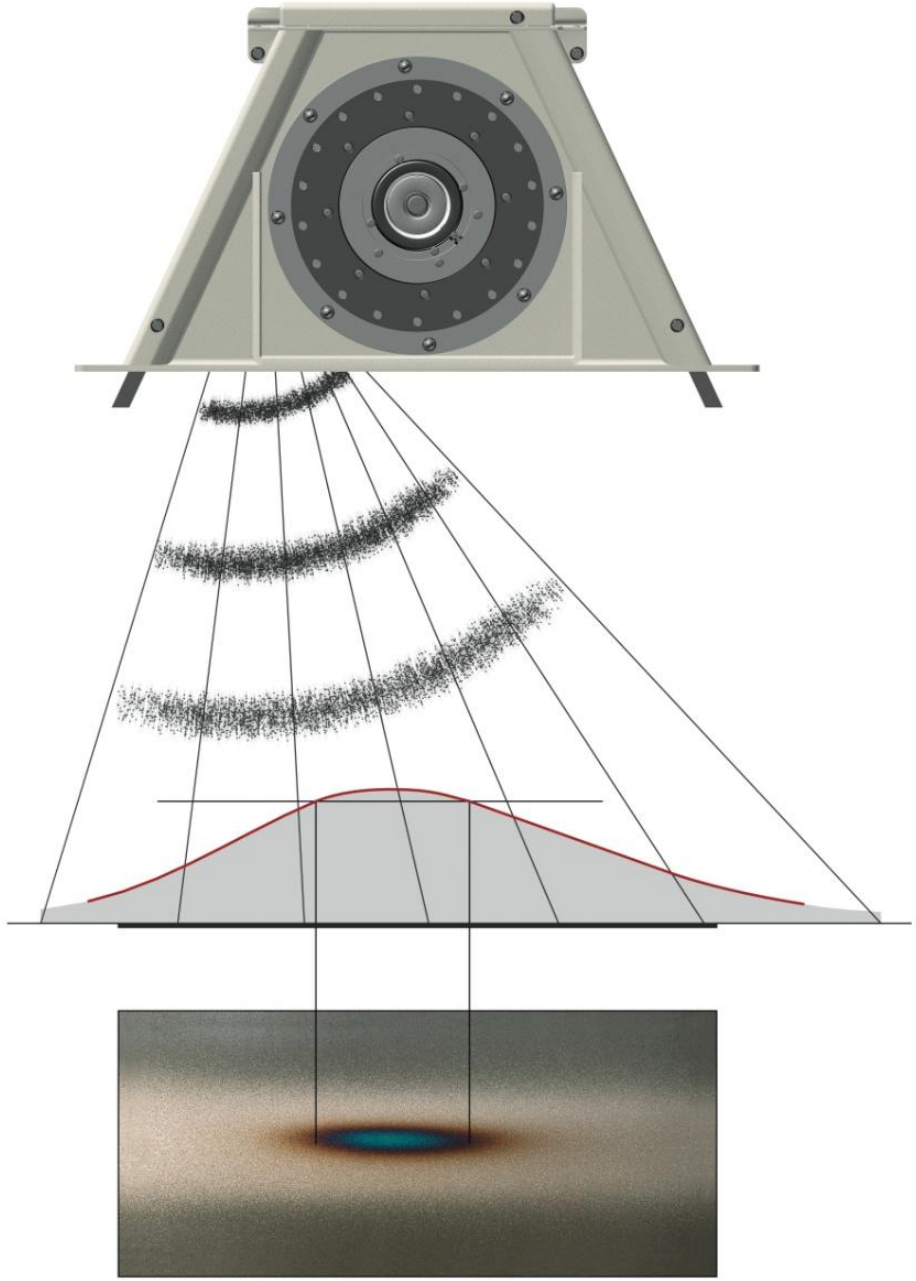
4. Abrasive cleaning and recycling

5. Dust collector

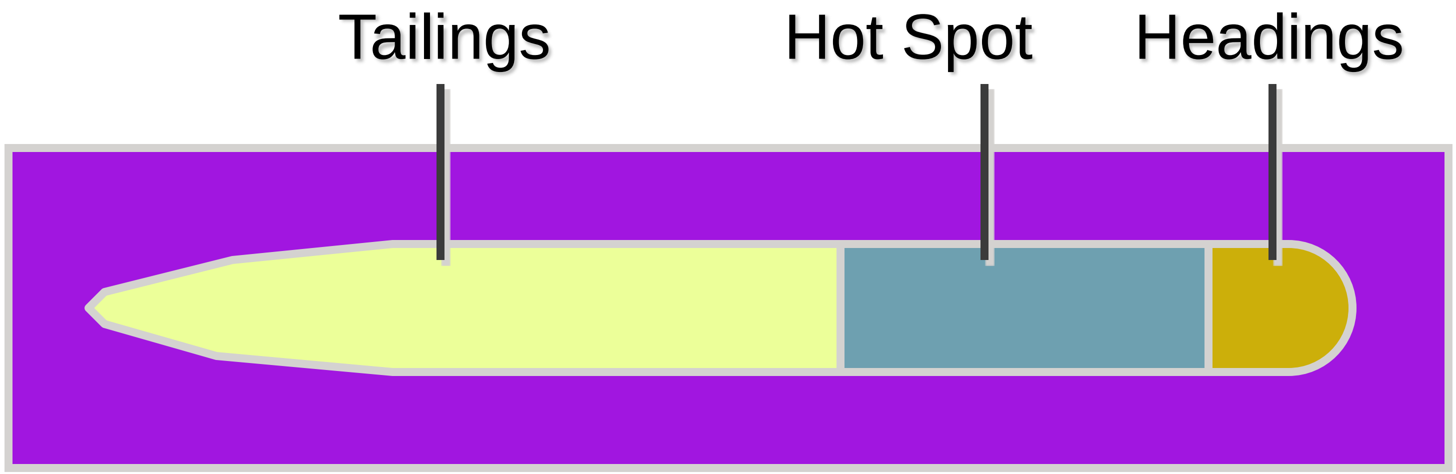
Wheel Blast Machine - Elements



COMPONENTS OF A BLAST WHEEL



Hot Spot



Blast Pattern Test Sheet

Hot Spot

Power Requirement of Wheel and Air systems

For abrasive flow of 2100 Lbs per minute

•21 operators

•½” nozzles

•Compressed air consumption 350 ft^3/min per nozzle

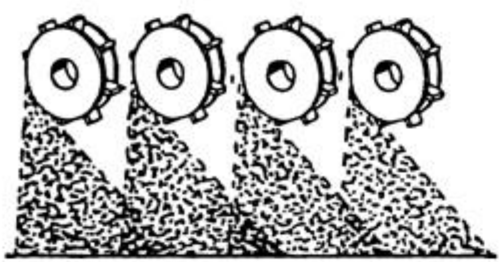
•Compressor power **1400 kW**

OR

4 wheels 20 HP each

80 HP (60 KW)

Energy factor 24 !!!



Comparison of media propulsion types

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.

Wheelblast – Pros and Cons

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

Blast Machine Maintenance

Operating Cost Elements

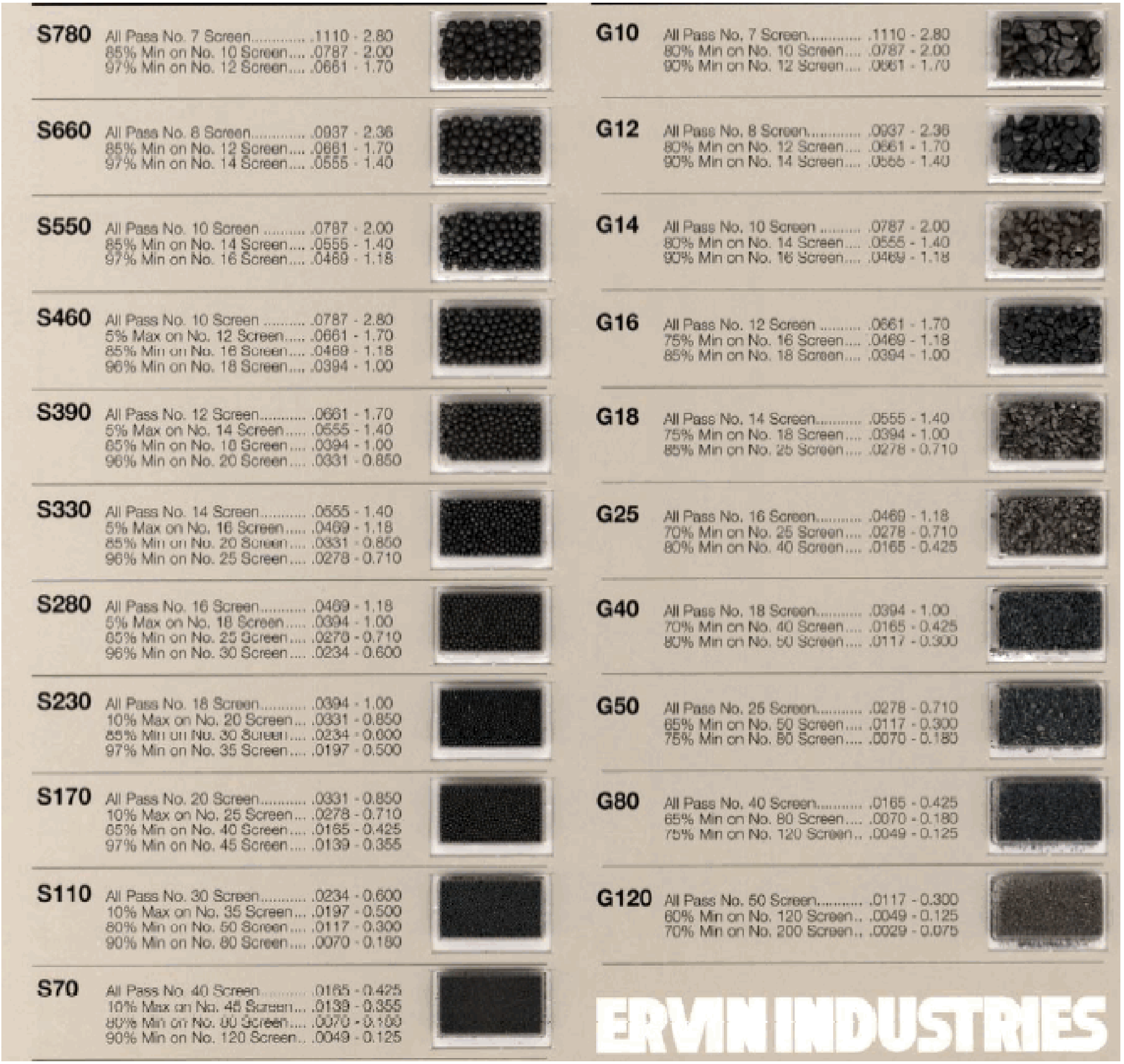
- **Primary heads - Wheelblast**
    - Electricity (total connected load x cost of power)
    - Media consumption / replenishment (total media flow x breakdown rate)
    - Cost of wheel parts – wheel parts
    - Cabinet and other component wear – liners, bearings, elevator belt & buckets, dust collector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

Elements of Operating Cost - Wheelblast

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.

Elements of Operating Cost - Airblast



Size	Screen Specification	in. - mm
S780	All Pass No. 7 Screen	.1110 - 2.80
	85% Min on No. 10 Screen	.0787 - 2.00
	97% Min on No. 12 Screen	.0661 - 1.70
S660	All Pass No. 8 Screen	.0937 - 2.36
	85% Min on No. 12 Screen	.0661 - 1.70
	97% Min on No. 14 Screen	.0555 - 1.40
S550	All Pass No. 10 Screen	.0787 - 2.00
	85% Min on No. 14 Screen	.0555 - 1.40
	97% Min on No. 16 Screen	.0469 - 1.18
S460	All Pass No. 10 Screen	.0787 - 2.80
	5% Max on No. 12 Screen	.0661 - 1.70
	85% Min on No. 16 Screen	.0469 - 1.18
	96% Min on No. 18 Screen	.0394 - 1.00
S390	All Pass No. 12 Screen	.0661 - 1.70
	5% Max on No. 14 Screen	.0555 - 1.40
	85% Min on No. 18 Screen	.0394 - 1.00
	96% Min on No. 20 Screen	.0331 - 0.850
S330	All Pass No. 14 Screen	.0555 - 1.40
	5% Max on No. 16 Screen	.0469 - 1.18
	85% Min on No. 20 Screen	.0331 - 0.850
	96% Min on No. 25 Screen	.0278 - 0.710
S280	All Pass No. 16 Screen	.0469 - 1.18
	5% Max on No. 18 Screen	.0394 - 1.00
	85% Min on No. 25 Screen	.0278 - 0.710
	96% Min on No. 30 Screen	.0234 - 0.600
S230	All Pass No. 18 Screen	.0394 - 1.00
	10% Max on No. 20 Screen	.0331 - 0.850
	85% Min on No. 30 Screen	.0234 - 0.600
	97% Min on No. 35 Screen	.0197 - 0.500
S170	All Pass No. 20 Screen	.0331 - 0.850
	10% Max on No. 25 Screen	.0278 - 0.710
	85% Min on No. 40 Screen	.0165 - 0.425
	97% Min on No. 45 Screen	.0139 - 0.355
S110	All Pass No. 30 Screen	.0234 - 0.600
	10% Max on No. 35 Screen	.0197 - 0.500
	80% Min on No. 50 Screen	.0117 - 0.300
	90% Min on No. 80 Screen	.0070 - 0.180
S70	All Pass No. 40 Screen	.0165 - 0.425
	10% Max on No. 45 Screen	.0139 - 0.355
	80% Min on No. 80 Screen	.0070 - 0.180
	90% Min on No. 120 Screen	.0049 - 0.125

Size	Screen Specification	in. - mm
G10	All Pass No. 7 Screen	.1110 - 2.80
	80% Min on No. 10 Screen	.0787 - 2.00
	90% Min on No. 12 Screen	.0661 - 1.70
G12	All Pass No. 8 Screen	.0937 - 2.36
	80% Min on No. 12 Screen	.0661 - 1.70
	90% Min on No. 14 Screen	.0555 - 1.40
G14	All Pass No. 10 Screen	.0787 - 2.00
	80% Min on No. 14 Screen	.0555 - 1.40
	90% Min on No. 16 Screen	.0469 - 1.18
G16	All Pass No. 12 Screen	.0661 - 1.70
	75% Min on No. 16 Screen	.0469 - 1.18
	85% Min on No. 18 Screen	.0394 - 1.00
G18	All Pass No. 14 Screen	.0555 - 1.40
	75% Min on No. 18 Screen	.0394 - 1.00
	85% Min on No. 25 Screen	.0278 - 0.710
G25	All Pass No. 16 Screen	.0469 - 1.18
	70% Min on No. 25 Screen	.0278 - 0.710
	80% Min on No. 40 Screen	.0165 - 0.425
G40	All Pass No. 18 Screen	.0394 - 1.00
	70% Min on No. 40 Screen	.0165 - 0.425
	80% Min on No. 50 Screen	.0117 - 0.300
G50	All Pass No. 25 Screen	.0278 - 0.710
	65% Min on No. 50 Screen	.0117 - 0.300
	75% Min on No. 80 Screen	.0070 - 0.180
G80	All Pass No. 40 Screen	.0165 - 0.425
	65% Min on No. 80 Screen	.0070 - 0.180
	75% Min on No. 120 Screen	.0049 - 0.125
G120	All Pass No. 50 Screen	.0117 - 0.300
	60% Min on No. 120 Screen	.0049 - 0.125
	70% Min on No. 200 Screen	.0029 - 0.075

ERVIN INDUSTRIES

Information courtesy:
Ervin Industries

BLAST MEDIA SIZES

Media size, shape and type

- Most commonly used peening media
- Manufactured to AMS specifications

ERVIN AMACAST
The World's Standard for Quality

300 Series Cast Stainless Steel Shot

Chemical Analysis

Chromium 16-20%
Nickel 6-10%
Silicon ....< 3%
Manganese ....< 2%

Microstructure

Austenitic. Becomes somewhat magnetic as work hardened.

Density

The density shall be greater than 7gm/cc.

General Appearance

The cast stainless steel shot shall be spherical in shape with a bright metallic appearance.

Hardness

Vickers Hardness Number	Rockwell Hardness Number C Scale	Rockwell Hardness Number B Scale
697	60	—
513	50	—
392	40	—
302	30	—
240	20	100
185	—	90
150	—	80

After use typical 470 HV

As produced typical 200 HV

Approximate hardness conversion numbers taken from ASTM E 140 tables 1 and 2.

Source: ervinindustries.com

Media: Shot vs. Grit

1st Choice = Smallest *Effective* Shot

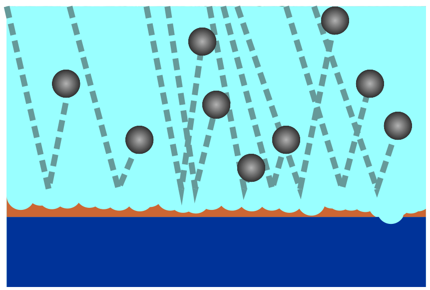
Flow: Volume in Pounds per Minute

1st Choice = Highest *Usable* Amount

Speed: Velocity at Blade Tip in FPS

1st Choice = Lowest *Effective* FPS

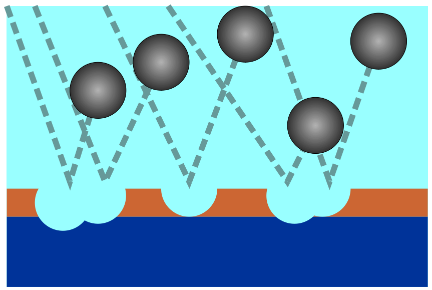
Media size and cleaning



Scale

Base metal

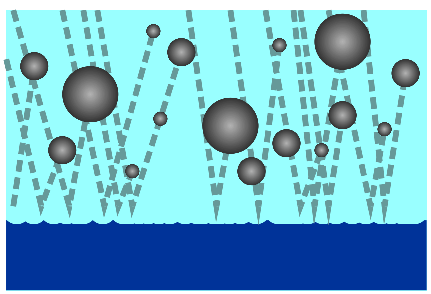
Too small



Scale

Base metal

Too big



Scale

Base metal

Balanced operating mix

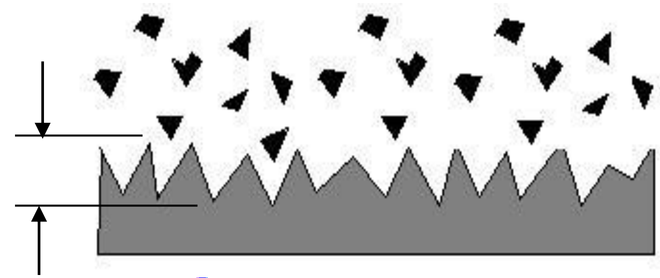
BLAST MEDIA SPECIFICATIONS

Abrasive Size	Nominal Dimensions inches	Average number of pellets per pound of shot
S-70	0.007	12,000,000
S-110	0.0117	3,390,000
S-170	0.0165	1,200,000
S-230	0.0232	420,000
S-280	0.028	250,000
S-330	0.0331	152,000
S-390	0.0394	93,000
S-460	0.0469	54,000
S-550	0.0555	32,000
S-660	0.0661	19,000
S-780	0.0787	11,000

- 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.

SHOT SIZE & COUNT

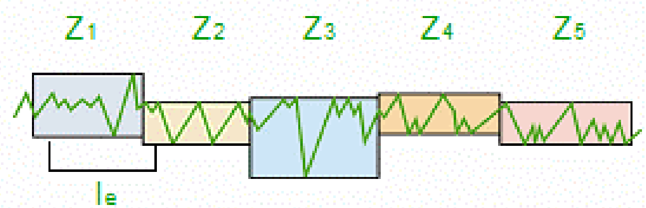
The profile depth (or height) is dependent on the size, type, hardness of abrasive, particle velocity and angle of impact



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 le.



$R_z = (Z_1 + Z_2 + Z_3 + Z_4 + Z_5)/5$

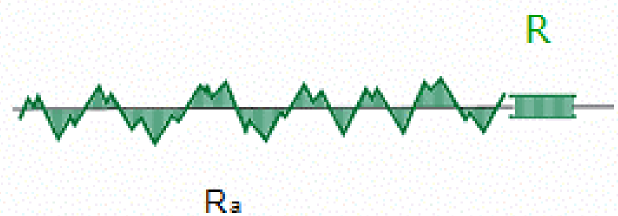
$R_{max} = Z_3$

Rmax Maximum Roughness Depth

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

Ra Mean Roughness

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

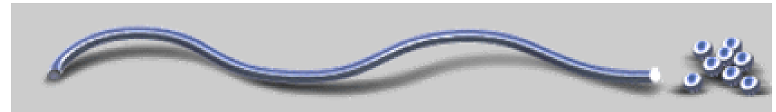


l_e = cut-off

R_a, R_z, R_{max} value depend on cut-off setting.

ROUGHNESS MEASUREMENTS

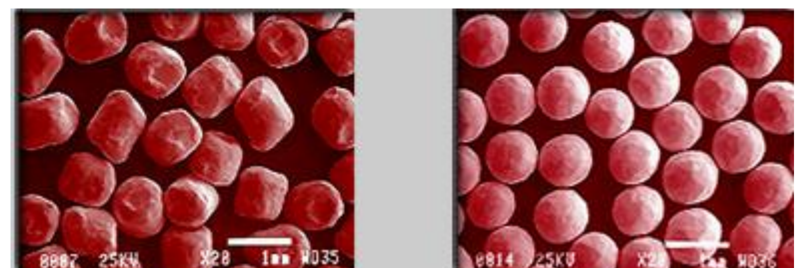
Cut wire



- 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

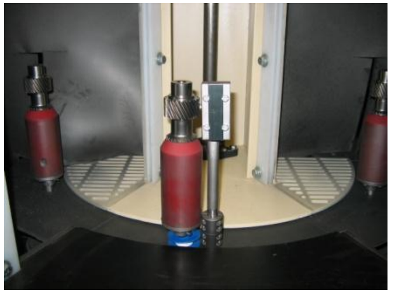


Normal Conditioning SAE J441 | Special Conditioning AMS 2431

Source: premiershot.com

Conditioned Cut Wire - Media size, shape and type

	BLAST CLEANING	SHOT PEENING
Purpose	Remove rust, scale and prepare surface prior to downstream coating	Induce compressive residual stress and enhance useful life
Application	Carried out on most metallic components	Generally on components that undergo cyclic loading
Result	Enhances life of coating, cosmetic finish	Part of maintenance procedure
Process Control	Etching, De-burring & other special processes	Quantifiable & measurable
Quality / Measurement	Generally visual to standards or preference	Specification driven



Blast Cleaning and Shot Peening

- Process to increase resistance to fatigue fracture of a part that undergoes cyclic loading.

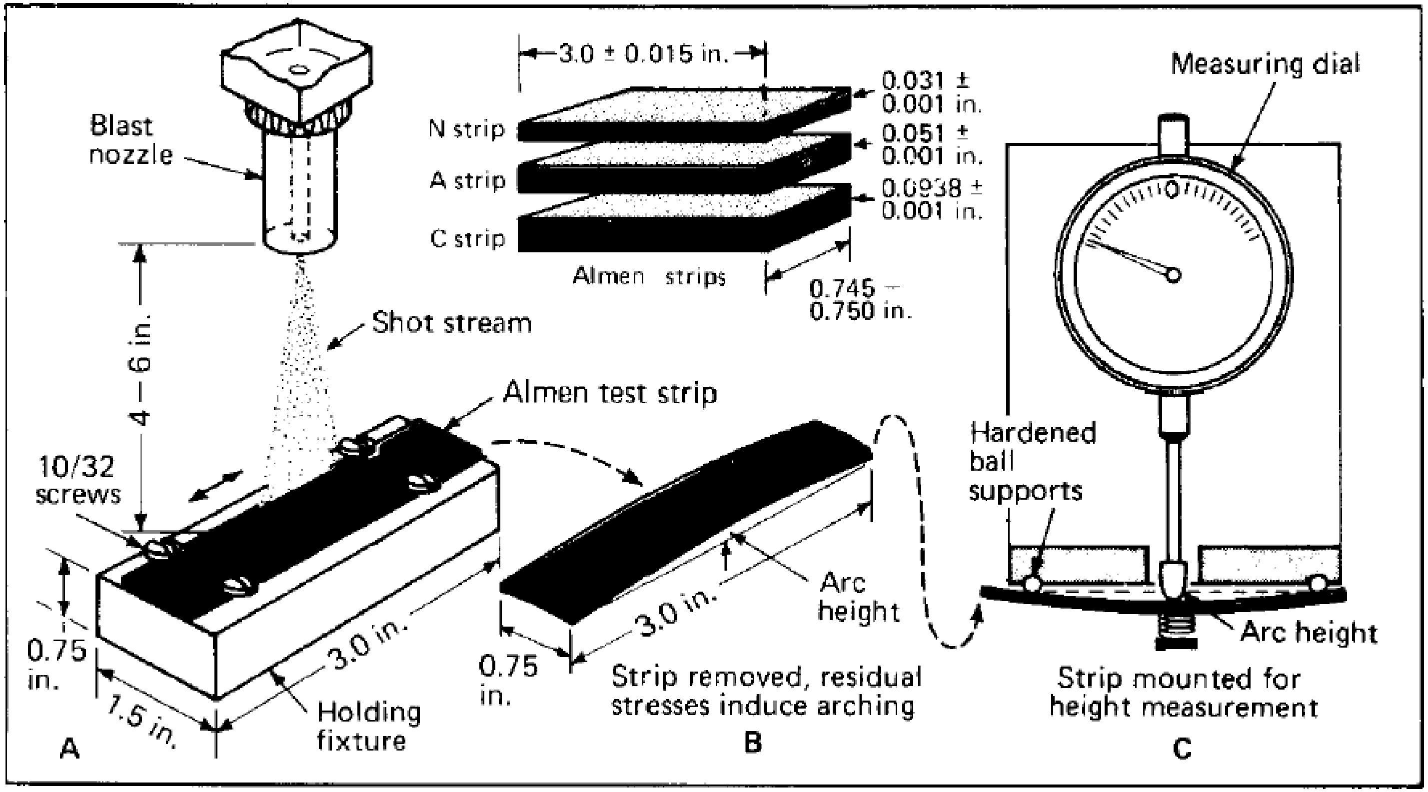
- Peening intensity is measured by deflection of a piece of spring steel called ‘Almen Strip’

- 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

Photo courtesy – Electronics Inc.

Fundamentals of Peening - Intensity



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.)

Steps to establish your peening process

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

Cleaning and Peening - Comparison

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

Cleaning and Peening - Comparison - Media