

Mini-Almen Strips: Applications and Use

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Shot Peening Training



Lecture Outline

- Introduction to Mini Almen Strips
- Why use a Mini Strip
- Desirable Applications
- Adhesion of Mini Strips
- Mini Almen Strip Gauge
- Verifying Mini Strip Performance
- Creating a Saturation Curve and Correlation chart for Mini Strips

What is a Mini- Strip?

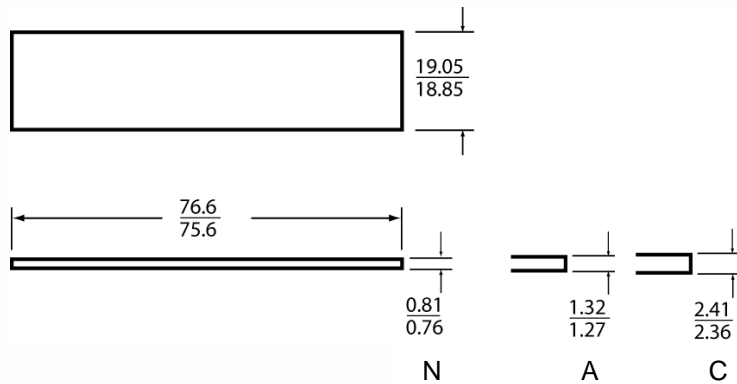


SPECIFICATIONS

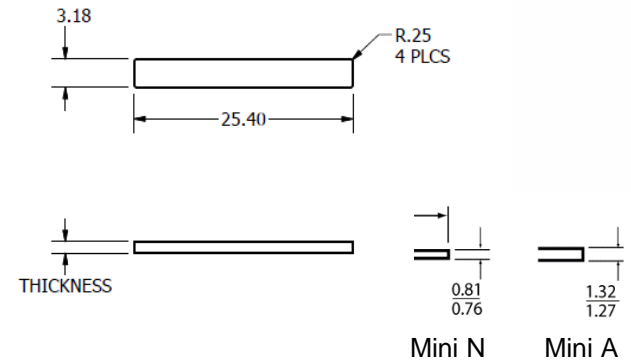
- Size: 25.4 mm x 3.18 mm
(1" x .125 ")
- Hardness: 44-50 HRc. (SAE J442)
- Material: SAE 1070 (SAE J442)
- Thickness:
 - A strip = 1.30 mm (.051")
 - N strip = 0.79 mm (.031")

Description

Standard Almen Strips



Mini Almen Strips



Why Use a Mini-Strip?

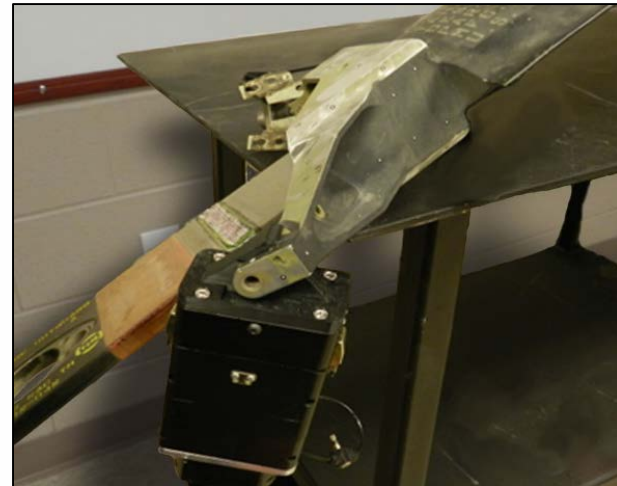
The Almen Mini-strip was developed to provide a means of more accurately verifying the shot peening intensity in areas that are inaccessible with standard size Almen strips and holders

Advantages of using Mini-Almen strips

- Pre-cut strips ensure consistency
 - Possible variation in masking of shaded strips
- Adhere directly to component after correlation, eliminating the need to create a test fixture
- Calculated mini strip intensity value, rather than a single point, arc-height correlation

Current Applications

- Areas smaller than a Standard Almen Strip
 - Example: Limited access to a small area on a 10-ft assembly



Current Applications

- Across Complex Geometry
 - Tail Rotor Blade Pitch Horn
 - Dove tail slots
 - Pitch Varying Housing



Current Applications

- Inner Diameter of Holes or Springs



Adhesion

- There are many different adhesion methods for using Mini Almen strips
 - Double-Sided tape
 - Contact Cement
 - Screws



Adhesion

Important: The adhesion method **must remain constant** when developing a correlation chart and testing intensities on the component in question

- Different bonding properties for each adhesion method
- Check for any **de-bonding** of the strip after peening
 - If de-bonding is present a stronger adhesive may be needed to obtain accurate arc-height measurements

Mini-Almen Strip Gauge

- Different design from standard Almen strips
- The entire length of a Mini Strip is used for arc-height measurements
- Mini Strips rest on 2 Notched holders instead of 4 round balls
- 2 Support pins in the back



Mini-Almen Strip Gauge

- Must be zeroed before use (just as the standard strip gauge) , using Mini Strip Zero Block (as shown)
- Mini Strips should rest on the lower surface of the end pins to get an accurate reading
- Due to small values of resultant arc-heights, pre-bow measurements are **required!**
- All adhesive material should be removed before obtaining an arc-height reading



Verifying the Mini-strip Performance

- In order to determine the effectiveness and accuracy of the Mini-strips, a series of tests was conducted to compare the performance of the Mini-strip to the performance of a standard Almen strip.
- Tests were performed on both the A and N strips.
- Tests were conducted to determine the following:
 1. Compare saturation curves for Almen strips and Mini-strips.
 2. Determine the arc height relationship between the Almen strips and the Mini-strips.
 3. Compare the arc height consistency of the Mini-strip
 4. Determine the conditions and limits for which the Mini-strips may be used.

- All tests were performed in a specially designed blast cabinet with a rotary table capable of peening 26 Almen strips in the same test.



- The Mini-strips were mounted onto the Almen holders, next to the Almen strip, using double sided tape.



Test Methods

- The strips were peened using two sets of conditions.
- **Test Method #1:** Generate saturation curves for both the Almen strips and the Mini-strips.
- **Test Method #2:** Peen multiple strips at T1 times to compare the resultant arc heights and distributions.

NOTE:

- **Prebow compensation** was employed on all of the tests in order to accurately determine the change in arc height.

Arc Height & Prebow Measurement

- Arc heights and prebow for Almen strips were measured on an Almen gage. (Fig. 1)
- Arc heights and prebow for Mini-strips were measured on a Mini-strip gage. (Fig. 2)

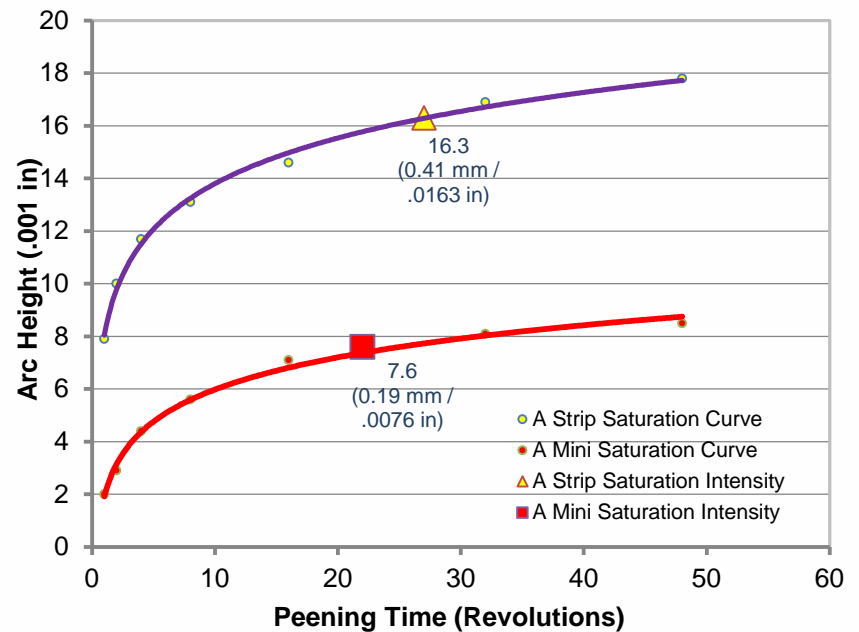
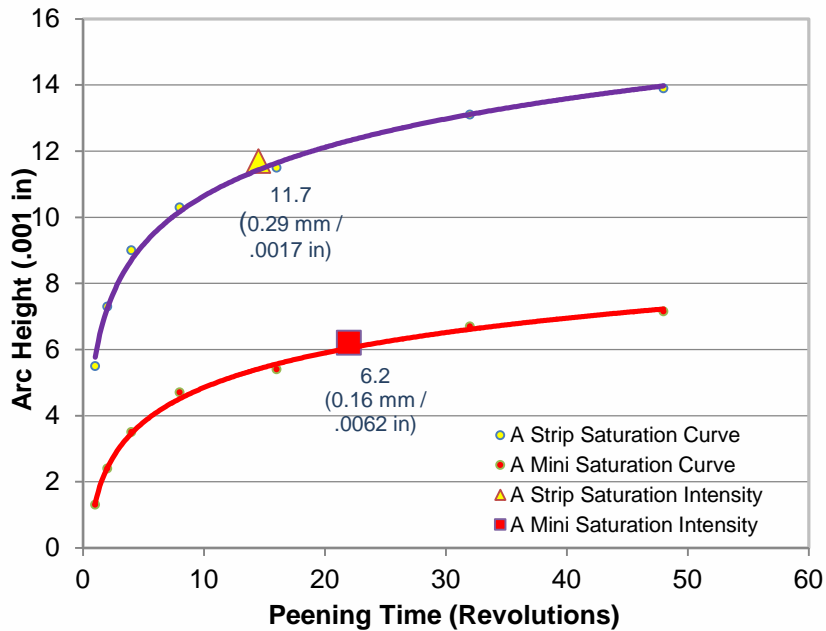


Test Method 1 – A Strips

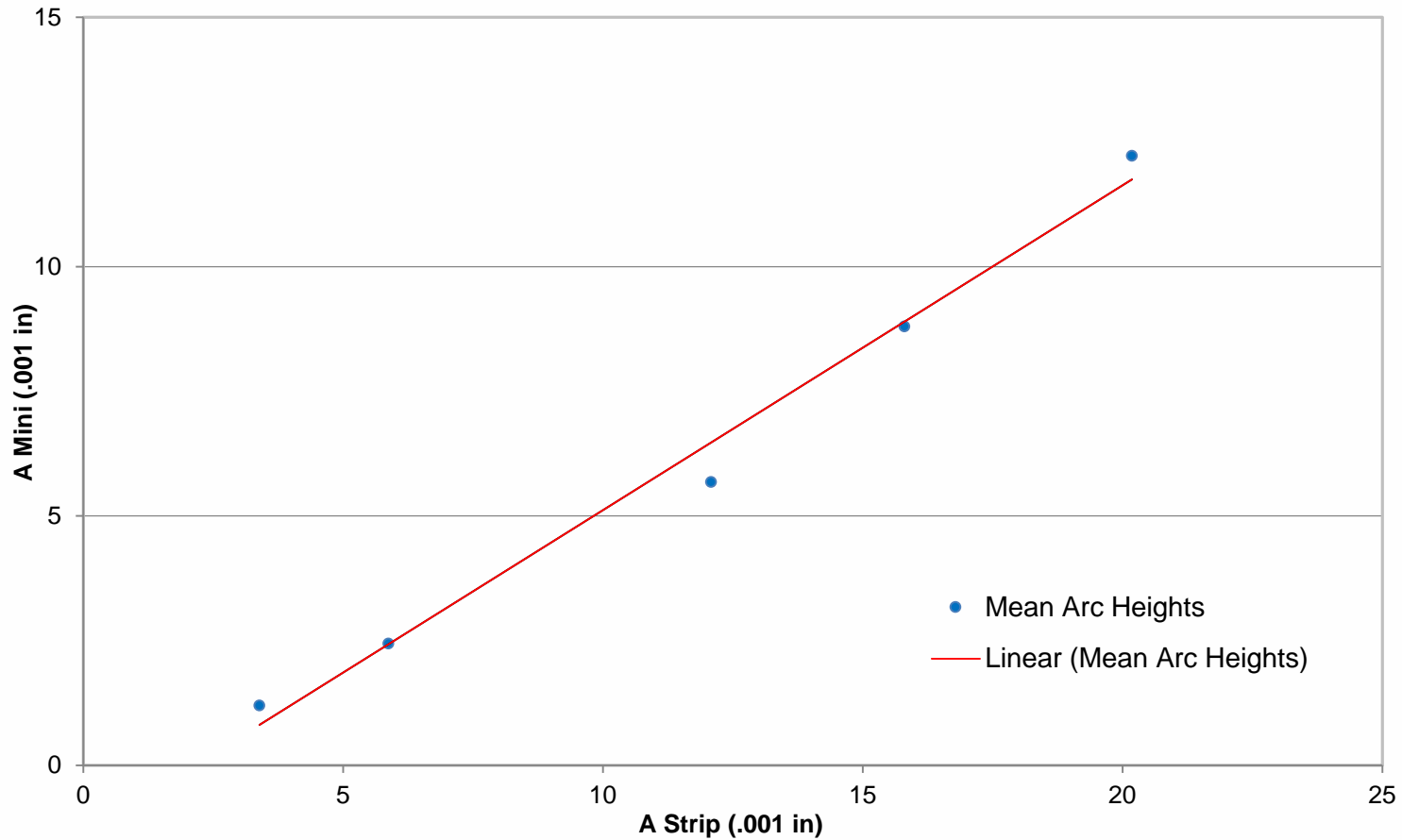
- Compare saturation curves for **A** Almen strips and **A** Mini Strips.
- Target intensities:
 1. 12A (0.30 mm / .012 in)
 2. 16A (0.40 mm / .016 in)

Saturation Curves

Almen A Strip & A Mini-Strip



Almen A Strips vs. Mini Strips Intensities of 3A, 6A, 12A, 16A, & 20A

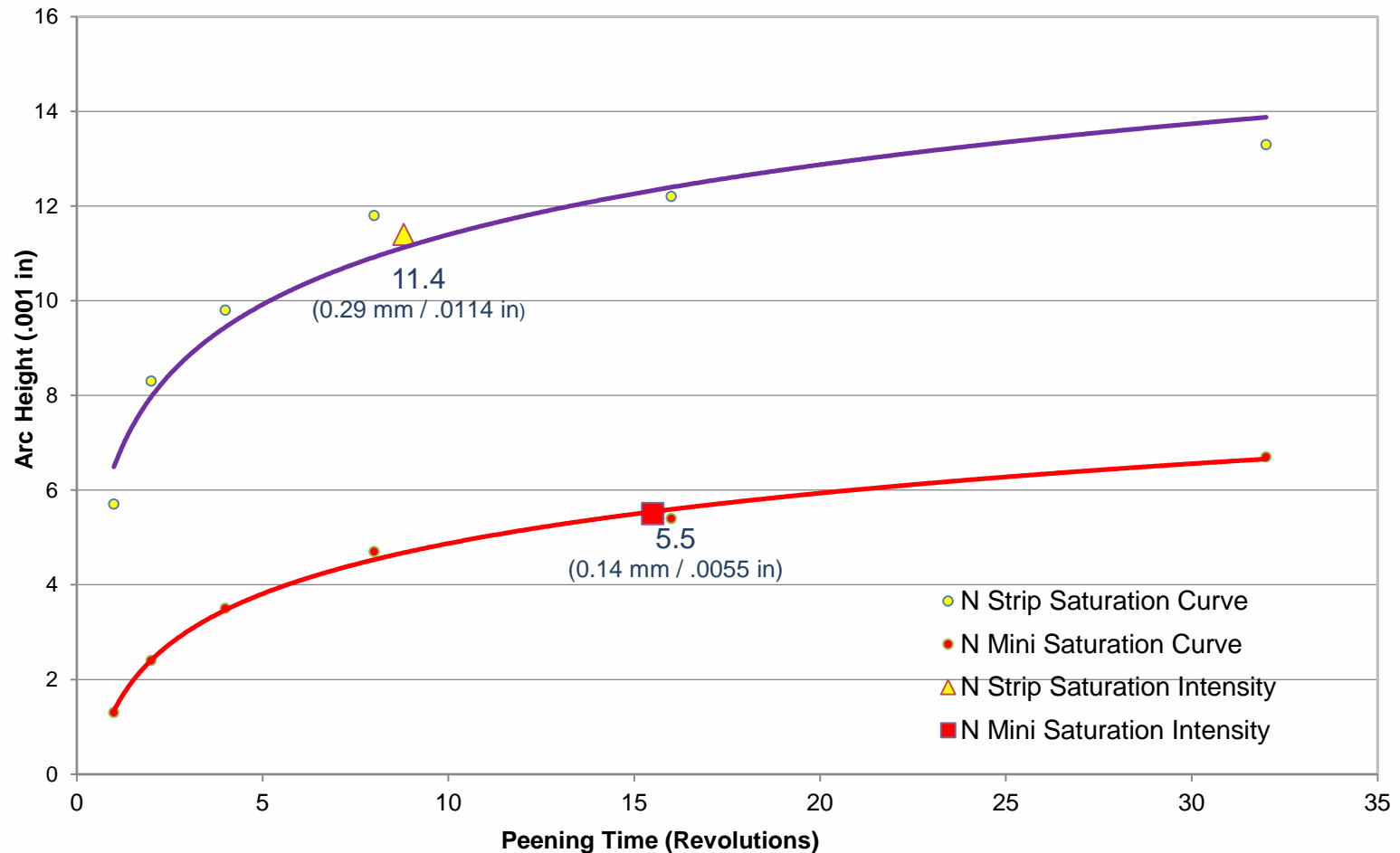


Test Method 1- N Strips

- Compare saturation curves for **N** Almen strips and **N** Mini Strips.
- Target intensity:
 1. 12N (0.30 mm / .012 in)

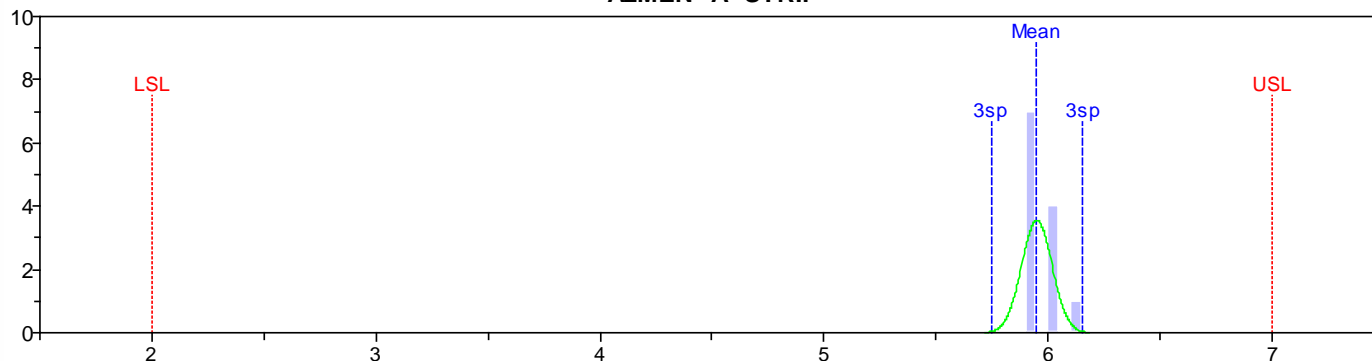
Saturation Curves

Almen N Strip & N Mini-Strip



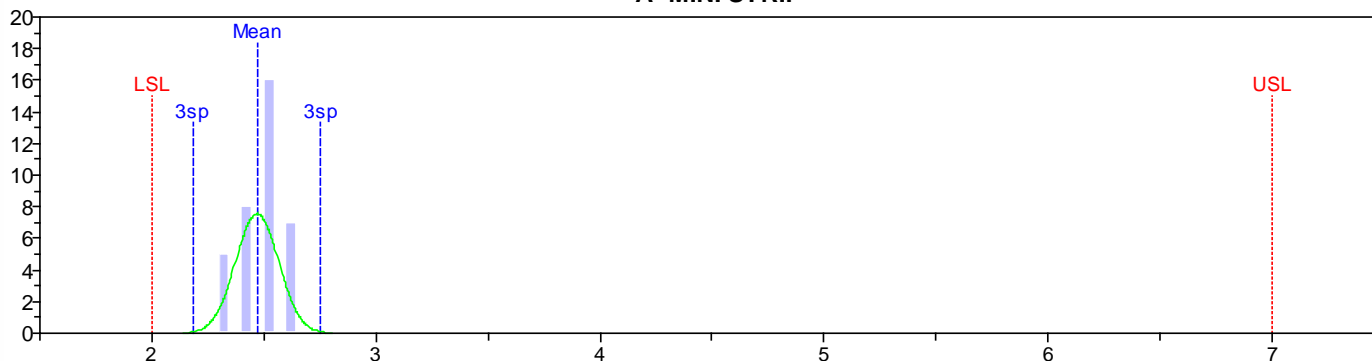
Correlation & Distribution at 6A Intensity

ALMEN "A" STRIP



Samples: 12 Cp: 12.36 (Scale: inches x.001)
Mean: 5.95
Std Dev: .06742

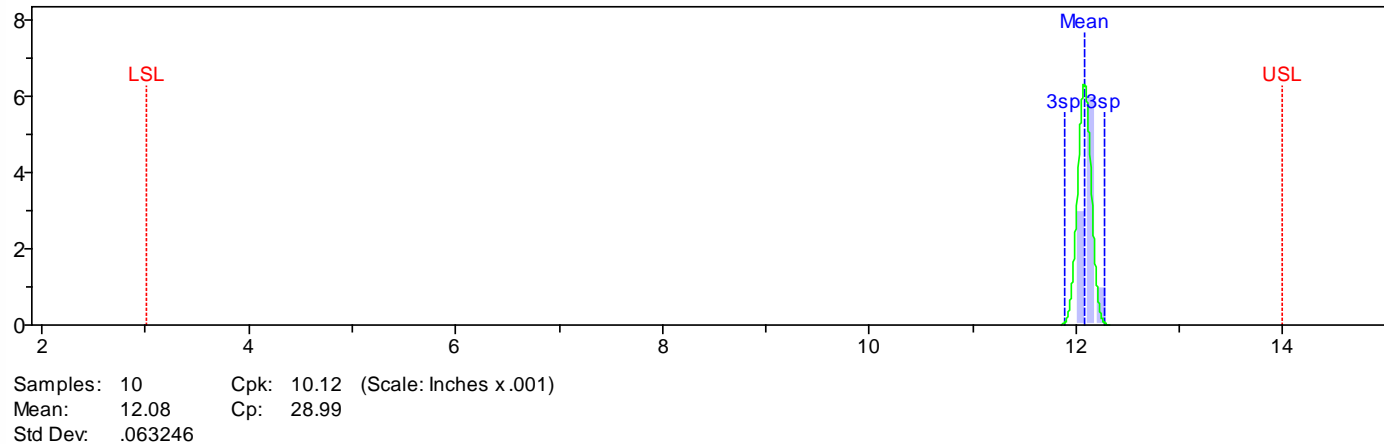
"A" MINI STRIP



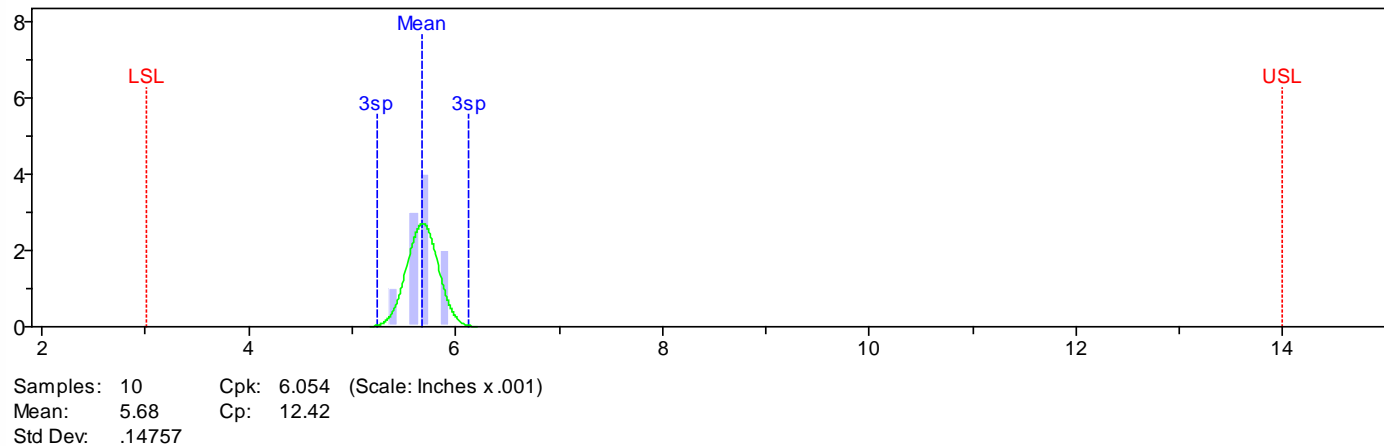
Samples: 36 Cp: 8.765 (Scale: inches x.001)
Mean: 2.46944
Std Dev: .095077

Correlation & Distribution at 12A Intensity

ALMEN "A" STRIP

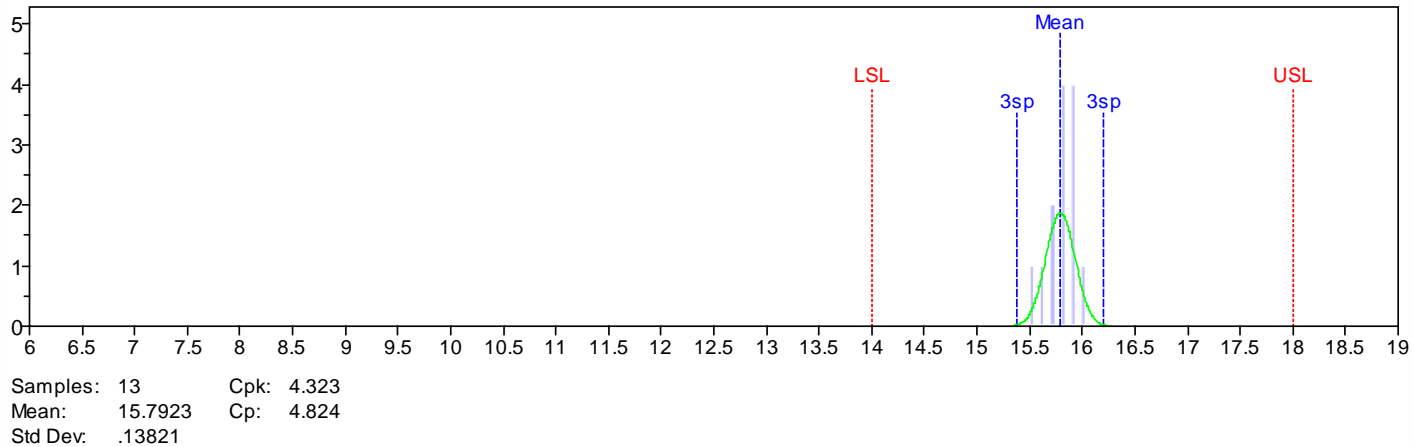


"A" MINI STRIP

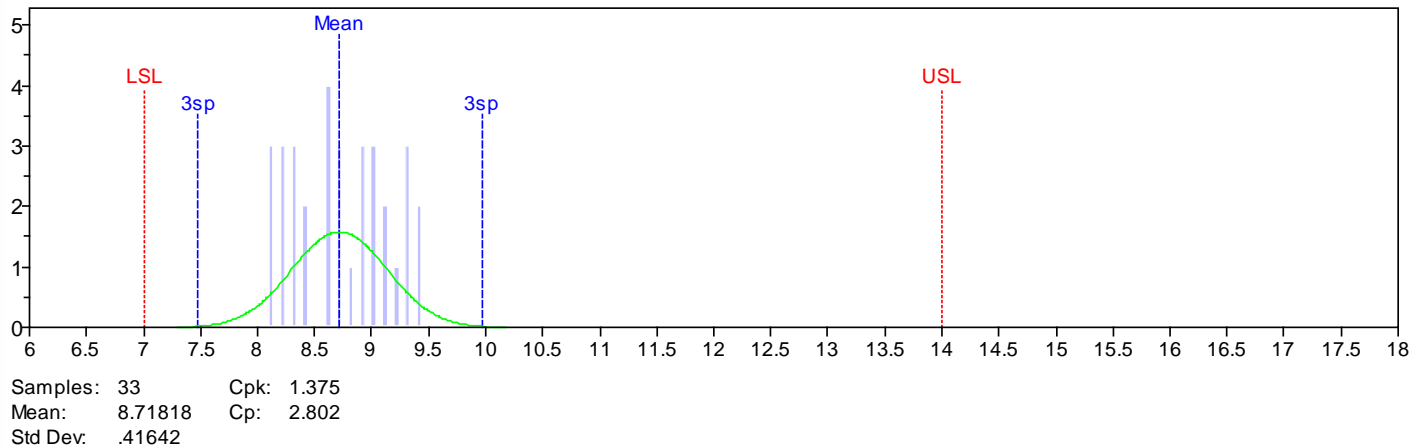


Correlation & Distribution at 16A Intensity

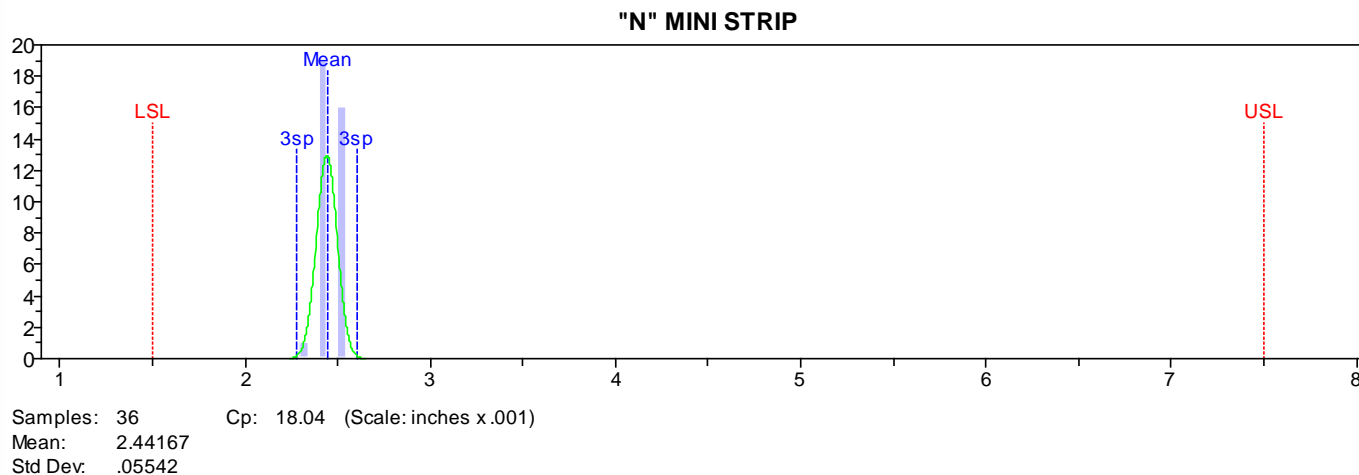
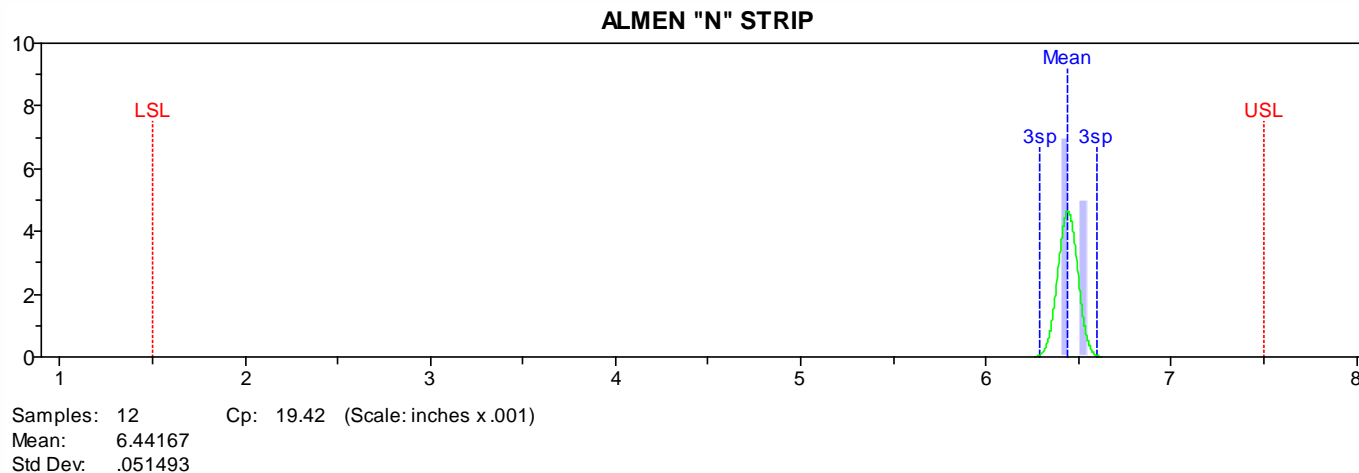
ALMEN "A" STRIP



"A" MINI STRIP

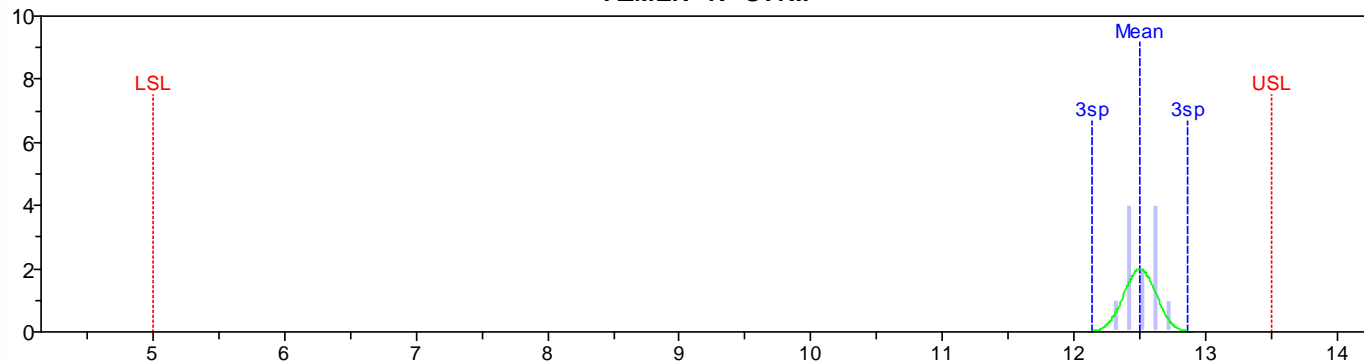


Correlation & Distribution at 6N Intensity



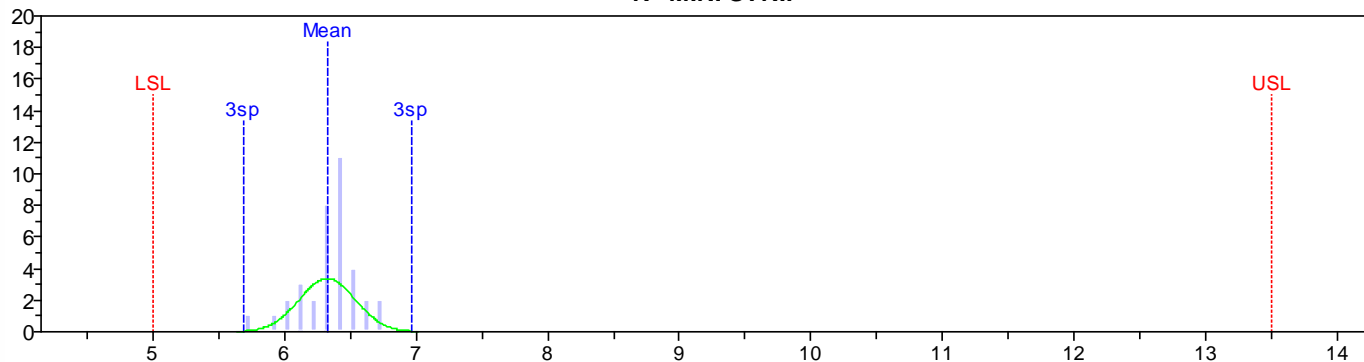
Correlation & Distribution at 12N Intensity

ALMEN "N" STRIP



Samples: 12 Cp: 11.75 (Scale: inches x.001)
Mean: 12.5
Std Dev: .1206

"N" MINI STRIP



Samples: 36 Cp: 6.652 (Scale: inches x.001)
Mean: 6.325
Std Dev: .21297

Summary of Test Results

- The Mini-strip can be used to accurately verifying the shot peening intensity in areas that are inaccessible with standard size Almen strips and holders.
- Double sided tape will effectively hold the strip for peening.
- The effective working range of the mini-strip is:
.003 - .007 in (0.08 - 0.18 mm).
- The working range in terms of standard Almen strips is:
N Strip Intensity = .006 - .012 in (0.15 – 0.30 mm)
A Strip Intensity = .006 - .015 in (0.15 – 0.38 mm)

Calculating a Mini-Intensity

- The arc height is not the intensity value
- A **saturation curve using Mini-Almen strips** is used to derive the **Mini Strip peening intensity** for each set of peening parameters
 - The Mini-Intensity is not a true intensity
 - The saturation curve is **developed from multiple arc heights** (data points) obtained by peening a series of Mini strips
 - Exposure may be time or incremental-based

Calculating a Mini-Intensity

- Just as with Standard Almen strips...
 - The **arc-height value** on the curve that **increases by 10%** when the **exposure time is doubled** is declared to be **the intensity**
 - The same saturation curve solver can be used to find the Mini-Intensity

Creating a Saturation Curve using Mini Strips

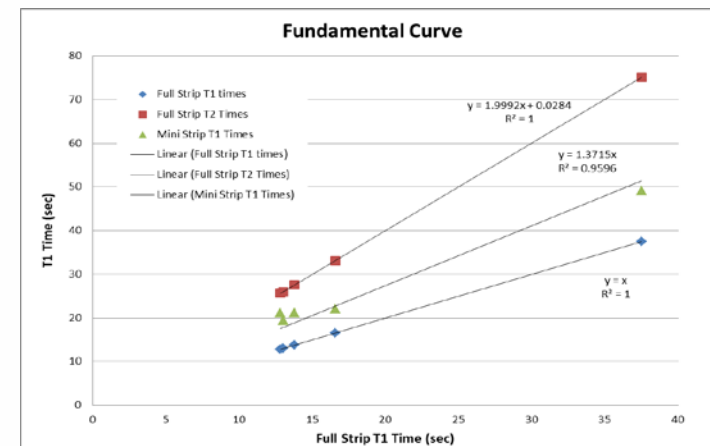
- Just as with Standard Almen Strips...
 - A **minimum of 4 data points** is required to construct a saturation curve
 - All strips must have **different exposure times** without changing machine parameters
 - Measure the arc-heights on a **Mini-strip Almen Gauge**

Creating a Saturation Curve using Mini Strips

- **Plot data on graph and draw a fitted curve** using the data points
- This gives us an **infinite number** of arc-heights with corresponding exposure times to use when looking for the **10% increase in arc height** for the **doubling of time**

Important Differences in Mini-Almen Strip Saturation Curves

- The Mini-Intensity **is not** a true intensity
 - It must be **correlated** to obtain the true intensity
- Mini-Almen strips will have a unique T1 time
 - When running a T1 validation strip, the correct Mini Strip T1 time should be used to get accurate results



Mini Strip Correlation Chart

- Correlation between Standard and Mini Almen Strips must be established **before** the intensity in small and hard-to-reach locations can be determined
- Correlation is conducted on a standard Almen Block in an open environment
 - Testing is conducted on the component

Developing a Mini Strip Correlation Chart

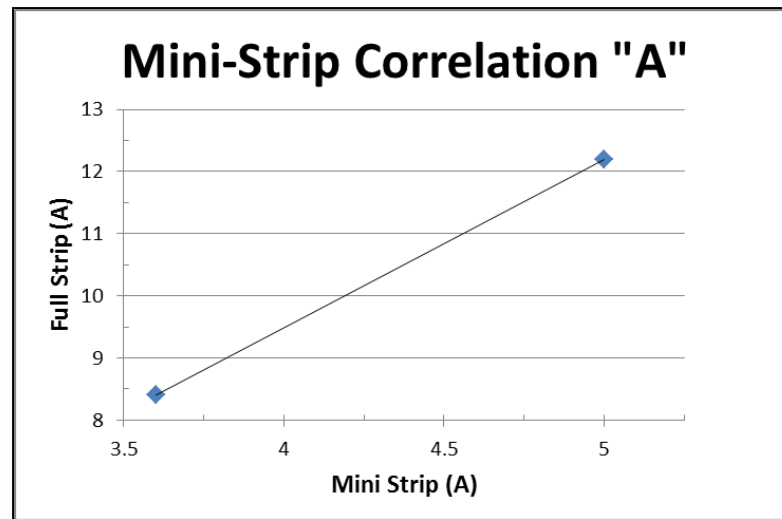
1. Run a saturation curve using standard Almen strips at the **upper intensity limit**.
2. Run a **saturation curve** using Mini Almen strips (using double-sided tape or contact cement) and expose it under the same parameters for upper intensity limit.

Developing a Mini Strip Correlation Chart

3. Run a saturation curve using standard Almen strips at the lower intensity limit.
4. Run a saturation curve using Mini Almen strips (using double-sided tape or contact cement) and expose it under the same parameters for the lower intensity limit

Developing a Mini Strip Correlation Chart

- Plot the standard strip intensity values along one axis and the corresponding Mini Strip intensity values along the other axis



- A correlation between the mini-strip intensities and the full-size strip intensities has been defined

Using the Mini Strip Correlation Chart

The correlation chart provides an acceptable mini-strip intensity range for the tested true intensity values

Important to Remember During Correlation and Testing

- The adhesion method used to create the correlation between Mini strips and Standard strips **must remain consistent** during testing
- Due to low arc-height readings, Pre-bow measurements are **required** to get accurate readings with the Mini-Almen strips
- Adhesive material **must be completely removed** before measuring resultant arc-height
 - Avoid causing damage to the Mini-Strip by scraping or hacking away adhesive material

Questions?