

# ALMEN STRIP RELIABILITY by Peter G. Bailey

GE Aircraft Engines conducted a series of tests to determine the reliability of Almen strip arc height measurements. The purpose was to provide basic data from which to develop the shot peen process beyond its currently perceived low technology level. Several factors were evaluated:

- Source of Almen strips
- Initial (pre-peen) strip flatness
- Strip hardness
- Strip thickness (estimated)
- Strip mounting and shot entrapment
- Effect of fluorescent tracer

## EXPERIMENTAL SET-UP

The experimental setup comprised a circular plate fixture with provision for circumferential mounting of Almen strips at the twelve "clock" positions at an 18" radius from the center rotation (Figure 1). A peening nozzle was positioned at 45 degrees to the strip surface and aimed along the strip length at an approximate 6" standoff distance. All data were taken on a 0.0001" digital gage.

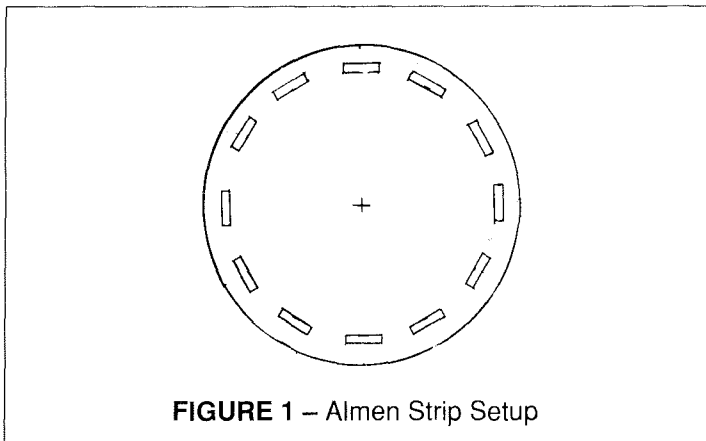


FIGURE 1 – Almen Strip Setup

## ALMEN STRIP SOURCE

"A" strips from one domestic and two overseas sources produced distributions varying approximately 0.1A around a 6A average (Figure 2).

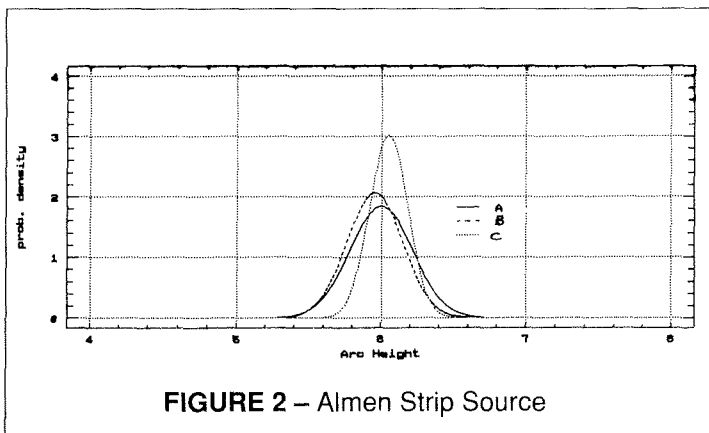


FIGURE 2 – Almen Strip Source

## INITIAL STRIP FLATNESS

The initial curvatures of both sides of a series of "A" strips were measured and then peened to 6A and re-measured. Several observations were made.. one that initial curvature of the side to be peened had no effect on the repeatability of the peened arc height. Second and more significant was that correcting the peened arc height by the initial curvature of the strip underside reduced the variation in arc height. Compare the normal distribution shown in Figure 3A with the random result of Figure 3B.

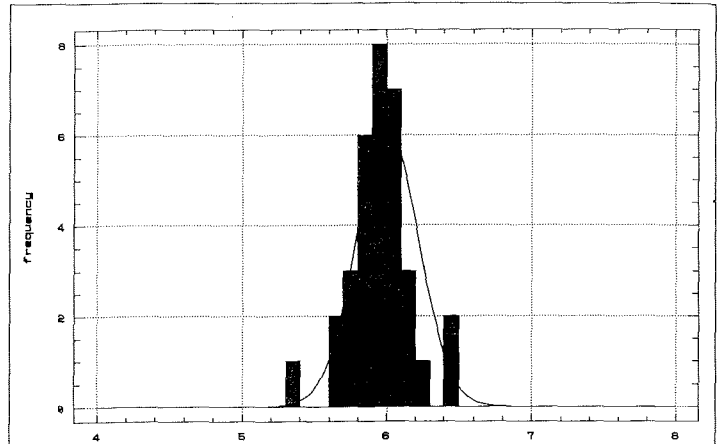


FIGURE 3A – Corrected Arc Height

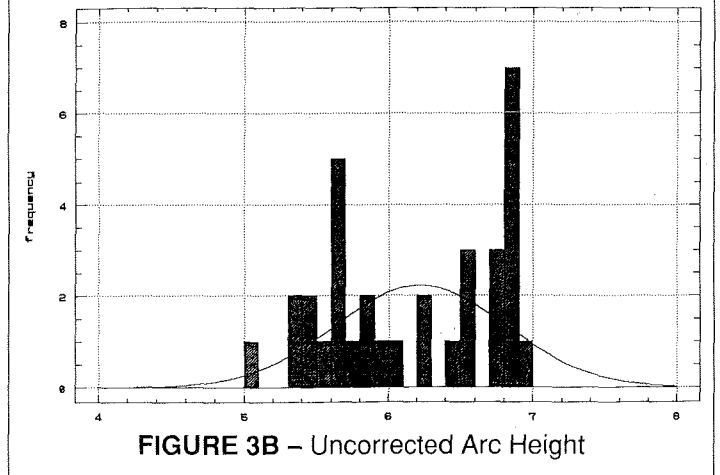


FIGURE 3B – Uncorrected Arc Height

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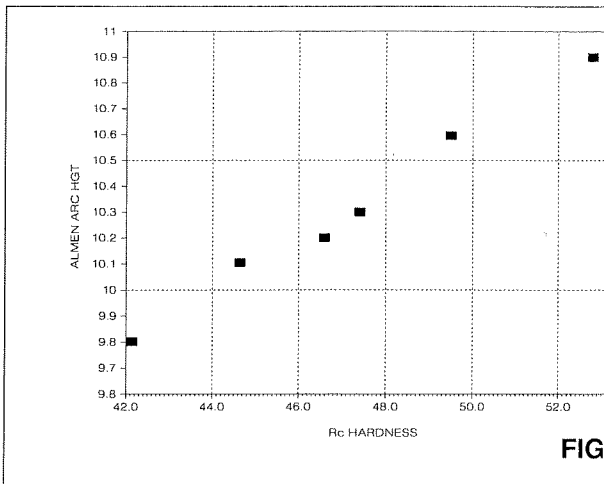
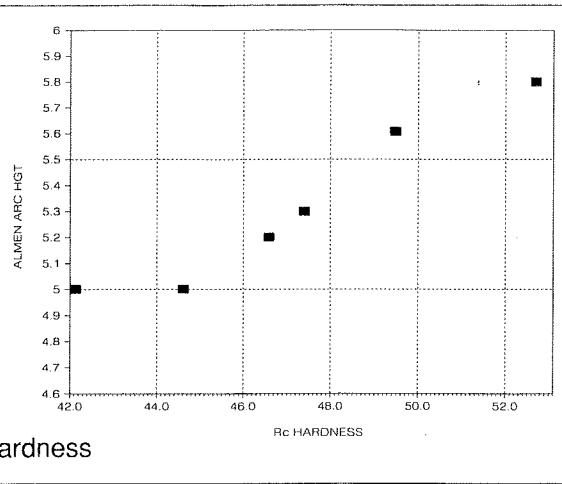


FIGURE 4 – Strip Hardness



### STRIP HARDNESS

A series of "A" Almen strips was supplied by a domestic vendor to a range of hardnesses. When peened to 5A and 10A, a +/-0.3A spread was observed for strips within the specification range of Rc44-50 (figure 4). Worthy of note is that no strips measured during that test and subsequently, vary anywhere near the specification limits but cluster at mid-specification.

### STRIP THICKNESS

An estimate of the affect of strip thickness tolerance was made by using the approximate 3X arc height factors from C to A and A to N strips. An arc height vs. strip thickness curve with C = 0.003", A = 0.009" and N = 0.027" shows a +/-0.0003" at the 9A point for a 0.051 +/-0.001 thickness range.

Figure 6. In the tests, two screws were loosened, either across, along or in a diagonal pattern.

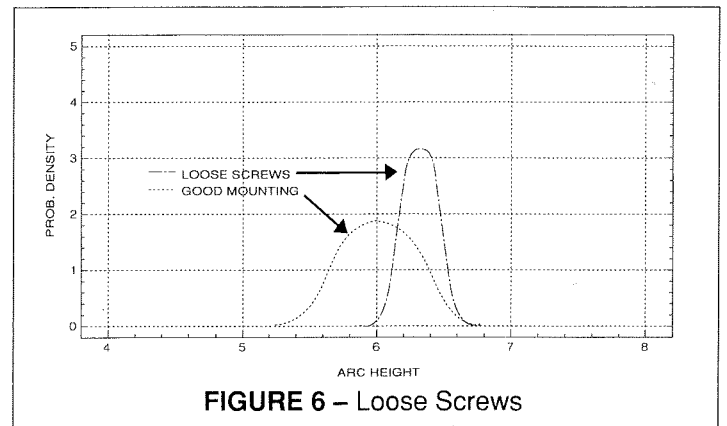


FIGURE 6 – Loose Screws

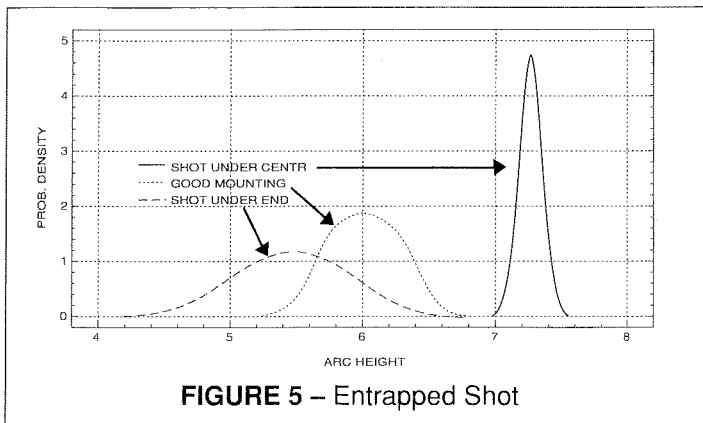


FIGURE 5 – Entrapped Shot

### ENTRAPPED SHOT

Shot trapped under the Almen strip was shown to have large affects. Entrapment under the center produced increased arc heights of over 1A, while end of strip trapped shot lowered the readings. These are actually manifestation of "peen forming" (Figure 5).

### LOOSE HOLD-DOWN SCREWS

Loosening the hold-down screws to simulate shot in the screw holes, giving the feel but not the reality of good strip clamping, had only minor affect on arc height as shown in

### EFFECT OF FLUORESCENT TRACER

Coatings of fluorescent tracer were shown not to have any cushioning effect at 5A and 10A as shown in Figure 7.

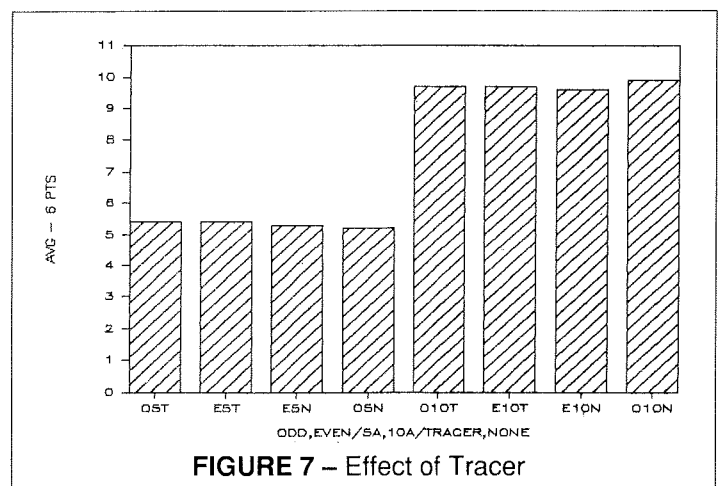


FIGURE 7 – Effect of Tracer

### OTHER FACTORS

Several other factors come to mind that we did not evaluate. There are undoubtedly others:  
 Concavity or convexity of Almen block surface.  
 Center or off-center arc height measurement along strip.