Covering the Basics: Intensity & Coverage

by Jack Champaigne

During an on-site training program, the Electronics Inc. training staff is available to answer questions and address problems. While some problems are unique to each facility, we find that both new and experienced personnel in shot peening are often challenged by the concept of appropriate peening coverage, and the confusion is often related to the saturation curve.

> Shot peening personnal often confuse Almen strip saturation time with the time needed to fully dent (i.e., cover) the actual part.

In the beginning, the relationship of peening time to Almen strip saturation time actually had merit. This is because the Almen strip material was based upon the item being peened, namely automotive valve springs of AISI 1070 cold drawn steel. J.O. Almen, the General Motors engineer that pioneered the research and development of modern shot peening in the U.S., designed a process control for this new technology of "shot blasting for fatigue life improvement". Using a small strip of flat steel of the same properties of the valve spring seemed like a good approach. Peening the test coupon caused it to bend in proportion to the shot stream energy and that was exactly what Almen was seeking.

With exposure, the test strip would undergo increased bending deflection until it was fully dented and then it was said to be "saturated", meaning additional exposure resulted in only a marginal increase in curvature. The measurement of the amount of curvature at saturation was then declared to be the peening intensity. The valve springs, being made from the same material with similar hardness, would exhibit a similar coverage rate with exposure as the test strip. It was therefore easy to describe the exposure time: it was the time needed for the saturation curve (i.e., strip arc height versus exposure time) to "flatten out".

The SAE technique in 1952 (Figure 1) was somewhat vague when it states in #5:

> *"The gage reading corresponding with the point A where the curve flattens out is generally taken as the measurement of the intensity of that particular peening. In some cases, this point is difficult to pick out and requires some judgment."*

SAE offered additional guidance in the 1961 revision of J443 when they added #6:

> *"When the machine settings are found that yield the desired arc height, the time of exposure of the part is also indicated."* Unfortunately this would lead to problems when it was later realized that parts of different hardness needed exposure times, both different from and unrelated to the Almen strip saturation. So, now there were two significant challenges: "some judgment" to determine intensity and further judgment as to part exposure time as linked to Almen strip saturation time.

Finally, in 1984, SAE adopted a mathematical approach to determining intensity from the saturation curve where they stated "Saturation has been attained when the "knee" of the curve is passed and increasingly longer periods of peening time are required for a measurable increase in test strip arc height. The location of the knee, point A shown in Figure 2 (next page), can be defined as that point on the curve beyond

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Figure 1

Procedures for Using Standard Shot-Peening Test Strip

SAE Recommended Practice

[illegible] approved January 1952.

The test strip A is used for arc height up to 0.024 A. (See arc-height designation given in SAE Standard Test Strip, Holder, and Gage for Shot Peening.) For greater degrees of peening, the C test strip is used.

Procedure Based on Arc-Height Exposure Time Relationship

General—1. Fasten the strip A or C tightly and centrally to the test-strip holder.

2. Expose the surface X (Fig. 2 of SAE Standard Test Strip, Holder, and Gage for Shot Peening) of the strip to the blast to be measured. Record the time of exposure or its equivalent.

3. Remove the strip from the holder and measure the arc height on the gage. The zero position of the gage must be frequently checked and, if necessary, adjusted.

4. Using different exposure times, repeat Steps 1, 2, and 3 sufficiently to determine a curve similar to Fig. 1.

5. The gage reading corresponding with the point A where the curve flattens out is generally taken as the measurement of the intensity of that particular peening. In some cases, this point is difficult to pick out and requires some judgment.

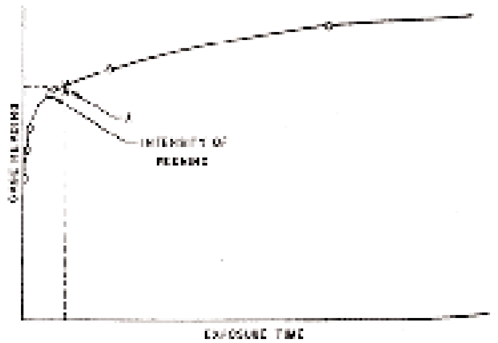

Fig. 1—Intensity Determination Curve

Production Setup Procedure—Blast Measurement—The procedure to be used in making a production setup in which a setting [illegible]

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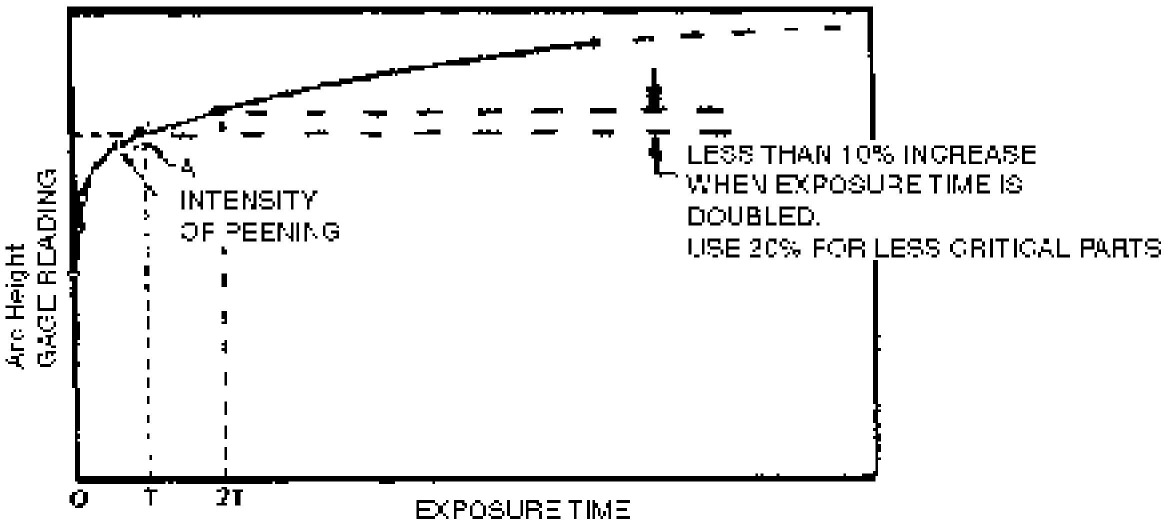
Figure 2
Source:
SAE J443, 1984



which the arc height does not increase more than "X" percent when the peening time is doubled. An arc height increase of 20% for doubled peening time may be adequate for some applications. An increase of 10% for doubled peening time defines the knee for critical applications."

Then, for the first time, SAE suggested that "If part hardness is appreciably different from the 44 to 50 Rockwell C hardness of the test strips, the time required to "saturate" the part also varies from that required to saturate the Almen strip. For instance, a hard carburized part will require more time to reach full visible coverage, while a softer part will require less time than the test strip. So, we have now addressed the two significant challenges posed earlier.

To further elaborate on the differences between intensity and coverage, SAE purged reference to coverage from J443 and then published J2277 "Shot Peening Coverage" as a separate document. (See "From SAE J2277" inset below.)

In the next issue of The Shot Peener, we willl explore the method of intensity determination and introduce the "Curve Solver" routine developed by Dr. David Kirk, past chairman of The International Scientific Committee on Shot Peening. Later, we will explore methods of determining coverage using graphical analysis, PeenTrace pens from Metal Improvement Company and coverage test strips. ●

From SAE J2277:

3. Coverage-Coverage is defined as the percentage of a surface that has been impacted by peening media. The minimum peening time required to obtain 100% coverage is determined by gradually increasing total peening time until the entire surface being peened exhibits overlapping dimpling. Coverages above 100% are multiples of the exposure time required to achieve 100% coverage.

3.1 Variation in Coverage of Part Versus Test Strip (SAE J443) – Peening time to reach full coverage on parts should not be associated with the times referenced in SAE J443 for determining shot peening intensity/saturation because of the parts' varied shapes and hardness. When all other factors are unchanged, soft surfaces typically require less peening time to achieve 100% coverage than hard surfaces since the size of each impression in soft surfaces is larger.

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