SURFACE VEHICLE STANDARD

J443™	NOV2024
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Procedures for Determining and Verifying Peening Intensity

RATIONALE

Changed document category from “Recommended Practice” to “Standard.” Resolved conflicting text and added commonly used methods for the verification process. Added method for verifying intensity derived from a Type 2 saturation curve.

1. SCOPE

This SAE Standard defines the method for deriving and verifying the peening intensity exerted onto a part surface during shot peening or other surface enhancement processes.

1.1 Application

1.1.1 Almen test strips are used to generate saturation curves in order to determine intensity and as a means of verifying the repeatability of a peening process.

1.1.2 The process of shot peening or other peening processes cannot, at present, be adequately controlled by nondestructive inspection of the peened parts; therefore, it is necessary to control the process itself to achieve consistent, reliable results. The use of Almen test strips with this standard is a method of measuring and verifying the peening process.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.2 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AMS2590 Rotary Flap Peening of Metal Parts

SAE J442 Test Strip, Holder, and Gage for Shot Peening

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

For more information on this standard, visit
https://www.sae.org/standards/content/J443_202411/

SAE J2277 Shot Peening Coverage Determination

SAE J2597 Computer Generated Shot Peening Saturation Curves

SAE HS-84 SAE Manual on Shot Peening

3. DEFINITIONS

3.1 ARC HEIGHT

A measurement of the curvature of an Almen test strip is the “arc height,” not the “intensity.” Exposing a single Almen test strip does not reveal intensity. Intensity can only be determined from a saturation curve developed by the procedure described in Section 4.

3.2 PRE-BOW

The measurement, either positive or negative, of the arc height of an Almen test strip prior to peening.

3.2.1 PRE-BOW COMPENSATION

Subtraction of the measured pre-bow from the measured arc height, after peening, to obtain the net change in the arc height from the peening process.

4. TECHNICAL REQUIREMENTS

4.1 Peening Intensity

Intensity is a function of the mass, the hardness, the velocity and the impingement angle of the shot and the distance traveled by the shot stream to the peened surface of an Almen test strip. For each set of peening parameters with a given media, an intensity value can be derived and documented.

4.2 Saturation Curve

A saturation curve, which is a plot of Almen test strip arc heights versus the duration of the exposure to the shot stream, is used to derive the peening intensity for a set of peening parameters. The saturation curve is developed from data points obtained by peening a series of Almen test strips while varying only the exposure. The exposure may be time-based (minutes, seconds, or inverse feed rate) or increment-based (number of passes, rotations, or cycles). In general, these points define a typical curve with a shape as exemplified in Figure 1 (Type 1). In some cases, saturation curves can appear as exemplified in Figure 2 (Type 2) and occur only when process variables do not permit the attainment of earlier data points.

The arc height value on the curve that increases by 10% when the exposure time is doubled is declared to be the intensity. The exposure time associated with the intensity value is designated as “T.” The exposure time at which the arc height increases by 10% is designated as “2T.” See 6.5 for recommended documentation of peening intensity. The use of computer-generated saturation curves that comply with SAE J2597 is recommended.

In cases where it appears that a data point is erroneous, it is permissible to repeat that test. If the same erroneous value is achieved, then the machine parameters shall be evaluated and adjusted as needed and a new saturation curve shall be generated.

Almen test strips exposed for extended periods can exhibit arc heights significantly greater than the “intensity” value. This does not imply that extensively long duration peening treatments are in violation of intensity requirements. Intensity is a value derived from a saturation curve and is constant for a given set of machine parameters, regardless of peening time.

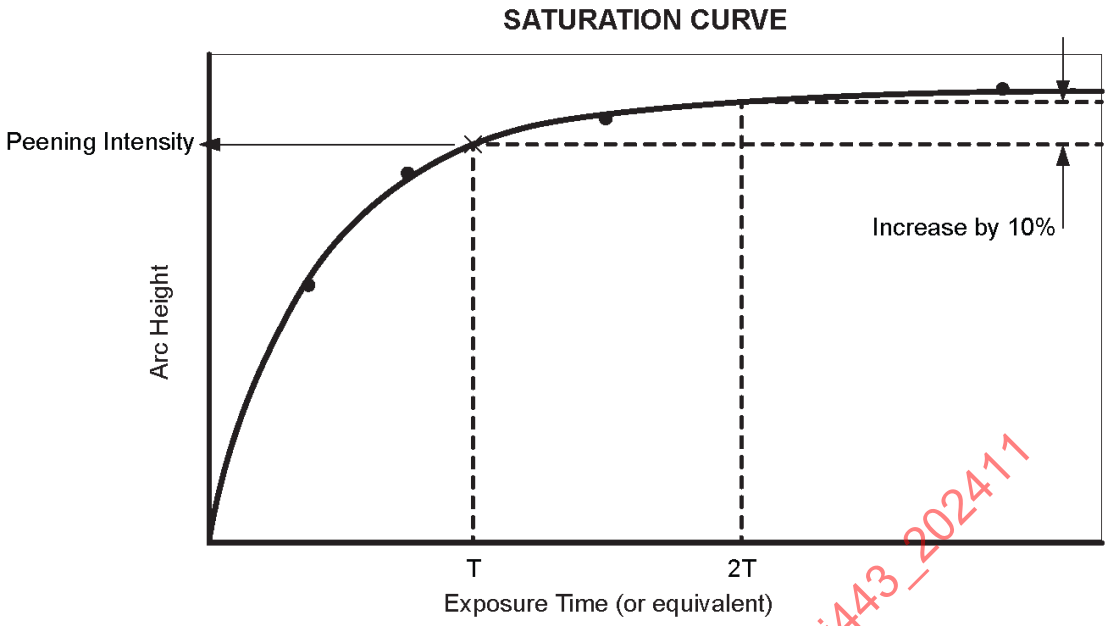

Figure 1 - Time based saturation curve (Type 1)

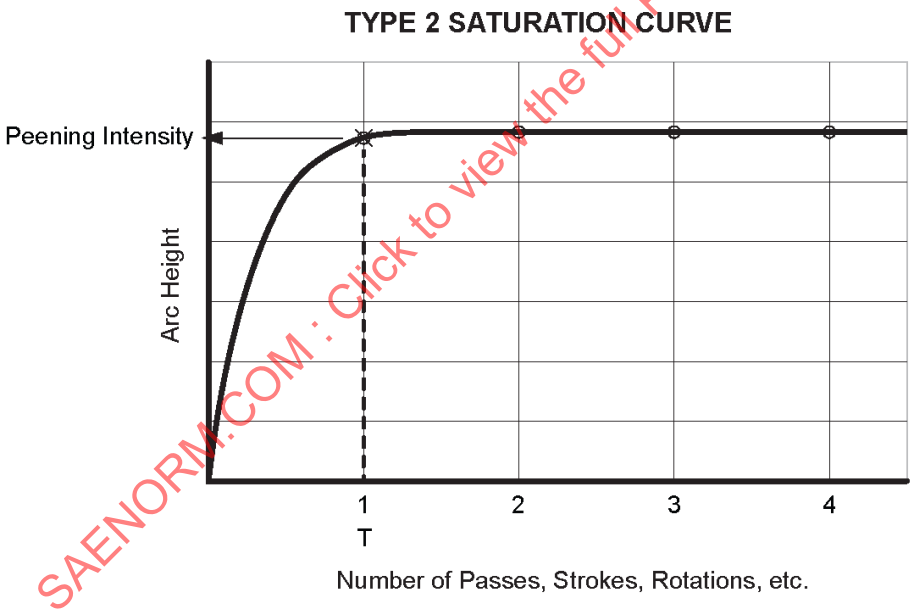

Figure 2 - Incremental based saturation curve (Type 2)

4.3 Intensity Determination Procedure

4.3.1 The zero position of the Almen test strip gage shall be checked with the zero block at each power on cycle, at a minimum, per SAE J442 and zeroed if necessary. Repeat this process if a suspected erroneous reading occurs. The Almen test strips, holder, gage, and zero block shall meet the requirements of SAE J442. Pre-bow measurements may be documented prior to peening and then used to provide net arc height measurements after peening. Verify that the Almen test strip holder meets the flatness requirements of SAE J442. Fasten the Almen test strip tightly and centrally to the Almen test strip holder. Avoid entrapment of any foreign material beneath the Almen test strip.

4.3.2 Subject the exposed surface of the Almen test strip (opposite the side measured in 4.3.4) to the peening stream to be measured. Record the time of exposure or its equivalent.

4.3.3 Remove the Almen test strip from the holder and verify that the peened side of the Almen test strip exhibits uniformly distributed (see 6.3) dents to assure that the Almen test strip surface area within the hold-down screws has not been blocked from the peening stream. The Almen test strip area under the hold-down screws does not require denting.

4.3.4 Measure the Almen test strip arc height with the indicator tip touching the un-peened side of the Almen test strip. Record the arc height measurement and, if using pre-bow compensation for net arc height response, correct the final arc height by subtracting the pre-bow measurement from the measured arc height (see 3.2.1). When sub-size strips are used, pre-bow compensation shall be used due to the relatively low final arc height values.

4.3.5 Using different exposure times or equivalents, without changing any other parameters, repeat 4.3.1 to 4.3.5 using a minimum of four Almen test strips to construct a saturation curve similar to Figures 1 or 2. The graph shall be constructed by using a minimum of four arc height measurements (data points) other than zero. Plot the data points and then draw a smooth curve representing the best fit of the data points. Alternatively, the use of computer-generated saturation curves which comply with SAE J2597 is recommended.

4.3.6 Peening intensity is determined by interpreting the saturation curve.

4.3.6.1 For Type 1 saturation curves, the intensity is defined as the arc height value on the curve that increases by 10% when the exposure time is doubled. For Type 2 saturation curves, the intensity is defined as the arc height value of the first data point (i.e., at the minimum possible exposure time, T), provided that the arc height increases by no more than 10% when the exposure time is doubled to time 2T.

4.3.6.2 For an intensity correlation using sub-size strips, a minimum of four sub-size Almen test strips are required for the upper and lower intensity limits. Using different exposure times or equivalents, without changing any other parameters, repeat 4.3.1 to 4.3.5 using a minimum of four sub-size Almen test strips to construct a saturation curve similar to Figures 1 or 2 for the lower intensity limit. Repeat these procedures for the upper intensity limit.

4.4 Production Setup - Intensity Determination Procedure

The procedure to be used in making a production setup in which a machine setting is to be determined for a desired intensity is described as follows:

4.4.1 For oriented part peening, provide a fixture which supports the Almen test strips in the required locations per the engineering drawings or work instruction. The setup shall be qualified by placing the Almen test strip fixtures into the machine in the same orientation to the shot stream as the part is subjected. For batch peening, provide a fixture which supports one or more strips in a static location within the blast stream. Do not allow the holders and strips to tumble in the batch of parts because tumbling can distort the strip performance.

4.4.2 The intensity shall be determined by exposing individual Almen test strips at each location in the Almen test strip fixture for increasing exposure times or equivalent and plotting the results from each location on separate saturation curves. REUSE OF ALMEN TEST STRIPS IS NOT PERMITTED EXCEPT WHEN MAGNETIC STRIP HOLDERS ARE USED FOR ROTARY PEENING, per AMS2590.

4.4.3 If the intensity derivation obtained from the curve is not within the specified tolerance, changes to the machine settings or shot characteristics (type, size, and hardness) allowed by the responsible authority are permissible. Sections 4.4.1 and 4.4.2 shall be repeated until the intensity is within the specified tolerance.

4.5 Production Procedure Intensity Verification

4.5.1 When the machine settings are found that yield an intensity within the specified tolerance, a means of process verification and control shall be implemented. Verification arc height readings shall be taken at a frequency determined to be appropriate for assuring consistent peening intensity. The frequency of verifications shall not be longer than 8 hours of operation. Two schemes for intensity confirmation - one involving a single holder and strip, the other involving multiple holders and strips - are offered in 4.5.2 and 4.5.2.1. Note that the practice of intensity confirmation does not constitute an intensity determination since this would require development of a full saturation curve, as outlined in 4.2.

4.5.2 When using a single holder on a fixture, a single strip may be used to verify intensity. Ideally the strip should be exposed for the time of T derived from the saturation curve. The arc height value at T on the saturation curve shall be the “target arc height.” When acceptable to the responsible authority, alternative verification times and their corresponding arc heights may be used when integral values of strokes or rotations are used, or when matching actual part processing time simplifies the process verification process for the machine operator. In these cases, a target arc height is obtained from the intersection of the saturation curve at the desired verification time for T (see Figure 3). In cases where intensity is derived from a Type 2 saturation curve, the smallest exposure time is used as T and its corresponding arc height is used as the target arc height. In all cases a single strip is subsequently peened for the selected verification time and shall repeat the target arc height to within 0.0015 inch (±0.038 mm) or other value acceptable to the responsible authority.

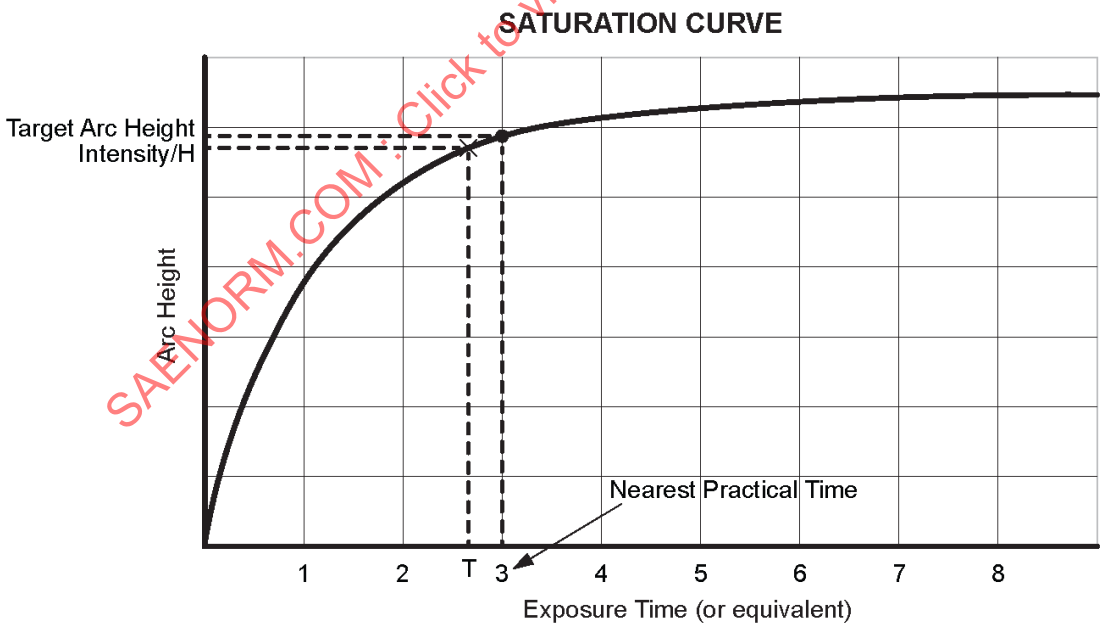

Figure 3 - Target arc height when using nearest practical time