SAE International™

SURFACE VEHICLE RECOMMENDED PRACTICE

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(R) Procedures for Using Standard Shot Peening Almen Strip

RATIONALE

Substantial revisions have been made to this document and the (R) symbol to the left of the document title indicates a complete revision.

Figure 1 - Eliminate “or less” from the arc height increase criteria so one and only one numeric answer can be derived from a given saturation curve. Use of “or less” may allow extremely long exposure times with corresponding increases in arc heights to erroneously qualify as intensity.

Figure 2 - Demonstrates that special cases exist where some peening techniques are accomplished with incremental number of passes through a machine, rotations of a turntable, strokes of a reciprocating nozzle or other methods and due to configuration and machine control constraints the Almen strip is saturated at the first exposure (least amount of exposure available) to the shot stream and additional passes do not significantly increase the arc height further.

Section 7.3 - It is common to use a fixture with multiple Almen holders for intensity tests. The peening intensity at each holder position must meet the requested values. The “saturation times” for each holder will be unique. When performing intensity verifications (one strip at saturation time) each holder must be exposed individually to its own saturation time and its arc height must be within the requested tolerance band. An alternative method is allowed by establishing “target arc heights” for use in intensity verification whereby the fixture can be used with all holders simultaneously and the obtained arc heights (within tolerance band) at each location must repeat the arc heights obtained in their respective saturation curve.

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1. SCOPE

This SAE Recommended Practice provides uniform procedures for using the standard shot peening Almen strips reported in SAE J442. Standard Almen strips are used to establish saturation, determine intensity, monitor repeatability of the shot peening machine operations, and can be used to predict a desired result on a part. It is recommended that the standard Almen strip A be used for intensities that produce arc heights of 0.10 mm A (0.004 in A) to 0.60 mm A (0.024 in A). For intensities below 0.10 mm A (0.004 in A), the standard N strip is recommended, and for intensities above 0.60 mm A (0.024 in A), the standard C strip is recommended. Use of SAE 2597 Computer Generated Shot Peening Saturation Curves is voluntary, existing shot peening processes that do not take advantage of computer generated saturation curves need not be changed to meet the requirements listed herein.

The process of shot peening, in common with many other 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.

2. REFERENCES

2.1 Applicable Publications

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.

2.1.1 SAE Publications

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

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

SAE J2277 Shot Peening Coverage Determination

SAE J2597 Computer Generated Shot Peening Saturation Curves

3. PEENING INTENSITY

Intensity is a function of impacting shot particle properties: mass hardness, velocity, angle of impingement and distance traveled to the surface of the Almen strip

4. SATURATION CURVE

A saturation curve is a plot of arc heights of peened standard test strips versus exposure times and is used to derive intensity. The saturation curve is developed from these data points obtained by peening a series of Almen strips while varying exposure times. Exposure time may be time-based (in minutes, seconds, inverse feed rate) or incremental-based (number of passes/rotations). In general these points define a typical curve with a shape as exemplified in Figure 1 (Type I). In some cases saturation curves may appear as shown, schematically, in Figure 2 (Type II). This will occur only when process variables do not permit attaining earlier data points.

The procedure for producing a saturation curve is detailed in Section 5.

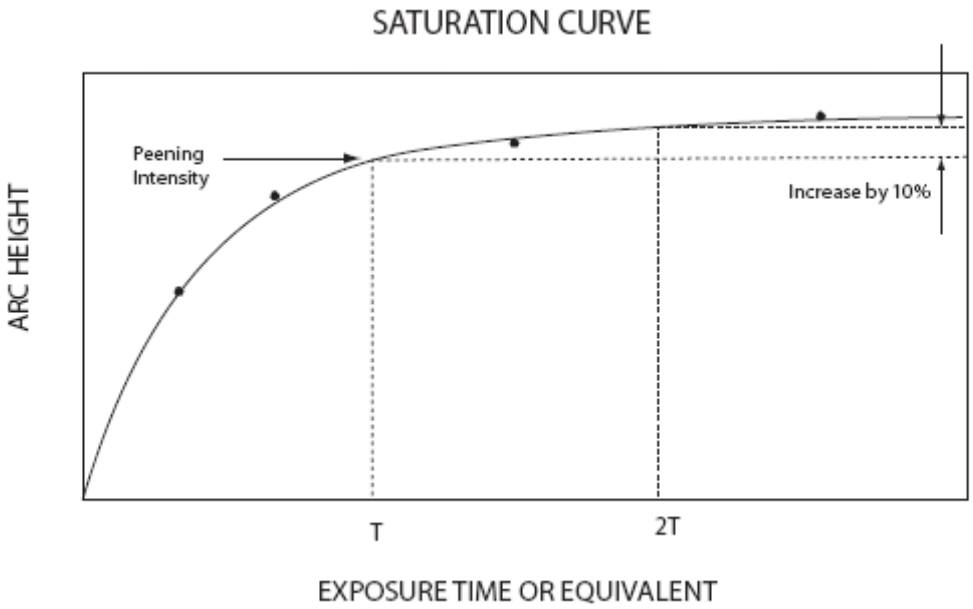

FIGURE 1 - TIME BASED SATURATION CURVE

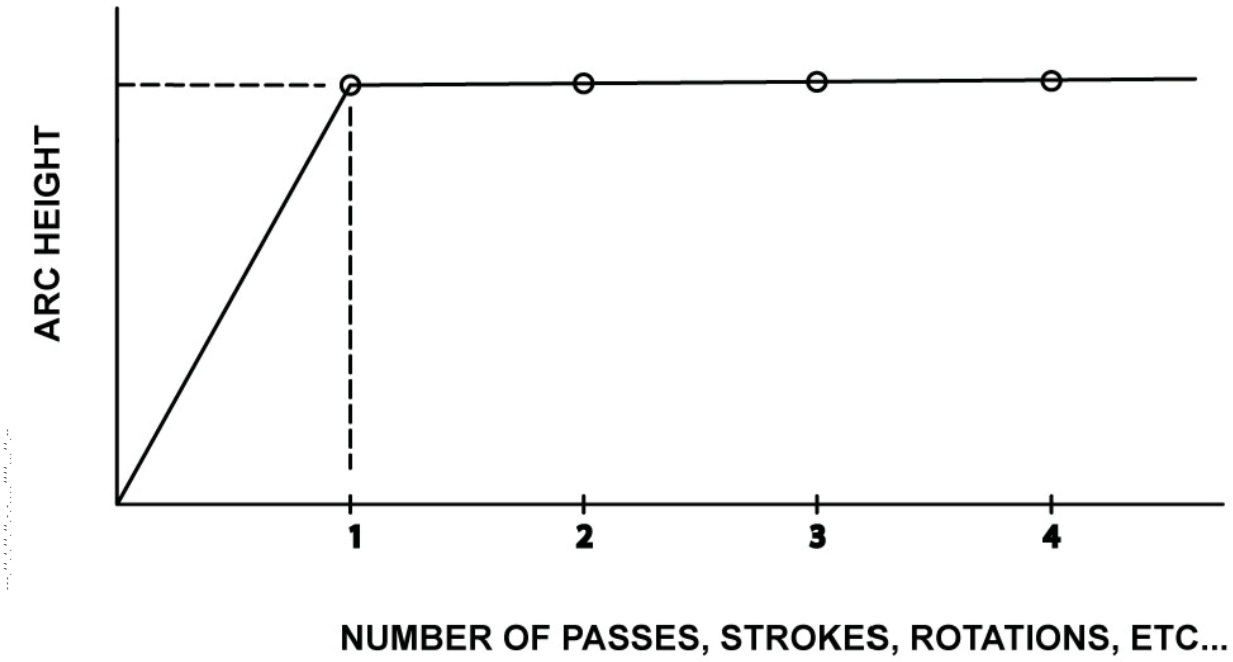

FIGURE 2 - SCHEMATIC REPRESENTATION OF SPECIAL CASES

The point on the curve where the arc height 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. The use of computer generated saturation curves which comply with SAE J2597 is recommended.

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

It should be noted that Almen strips exposed for extended periods may 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.

5. INTENSITY DERIVATION PROCEDURE

General—Prior to use, the zero position of the gage shall be checked with a flat calibration block (see SAE J442) and, if necessary, adjusted. Almen strips and holder shall meet the requirements of SAE J442.

5.1 Fasten the Almen strip tightly and centrally to the Almen strip holder, avoiding entrapment of any foreign material..

5.2 Expose surface "X" (SAE J442) of the Almen strip to the peening stream to be measured. Record the time of exposure or its equivalent (number of passes, inverse federate, etc.).

5.3 Remove the Almen strip from the holder and measure the arc height on the gage, ensuring that the indicator stem contacts the unpeened surface of the Almen strip.

5.4 Using different exposure times or equivalents, repeat steps 1, 2, and 3 sufficiently (minimum of 4 Almen strips) to construct a saturation curve similar to Figure 1 or 2.

5.5 Peening intensity is determined by interpreting the saturation curve. Intensity is the value of the arc height at time T, which increases by 10% when the exposure time is doubled – time 2T. The graph shall be constructed by using a minimum of four points other than zero.

5.5.1 For type I saturation curves the intensity is defined as the arc height value which increases by 10% when the exposure time is doubled.

5.5.2 For type II 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 - time 2t. The intensity shall be interpreted as the arc height value of the first strip reading.

5.6 Almen strips shall exhibit uniform coverage. This requirement ensures that portions of surface “X” (as defined in SAE J442), exclusive of hold down screws, have not been shielded from the peening stream. It should be noted that part coverage time cannot be associated with Almen strip saturation time (see SAE J2277 for part coverage). NOTE: Measured arc heights may be corrected to reflect only the net increase in arc height as a result of exposure to the shot stream. To perform this correction, measure and record the arc height of the test strip prior to exposure and then subtract this value from the arc height measured subsequent to exposure.

6. PRODUCTION SETUP PROCEDURE - INTENSITY MEASUREMENT

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

6.1 Provide fixturing which supports the Almen strip(s) in a manner to simulate the selected surfaces of the part to be peened. Almen strip holders (see SAE J442) shall be mounted on the fixture to duplicate the angle and location of these areas. Setup shall be qualified by placing the Almen strip setup fixture in the machine in the same orientation to the shot stream that the part will be exposed during processing. Adjust machine settings and orient test fixture as necessary to yield designated intensities. Nozzle centerline positions or wheel cages should be set so that they produce an impact angle of impingement greater than 30 degrees.

6.2 Intensity shall be determined by exposing individual Almen strips at each location in the Almen strip holding fixture for increasing periods of time and plotting the results from each location on a saturation curve. Re-use of Almen strips is not permitted except when magnetic strip holders are used for roto-peening or flapper peening.

6.3 If one or more of the intensities falls outside the specified tolerance, change the machine settings or shot characteristics not specified by the responsible authority. Repeat steps 6.1 and 6.2 until the intensity falls within the specified tolerance.

7. VERIFICATION OF INTENSITY

7.1 When the machine settings are found that yield intensities that fall within the specified tolerance, a means of intensity verification and control shall be implemented. Confirmation readings shall be taken at a frequency determined to be appropriate to assure consistent peening intensity, generally no longer than 8 h of operation

7.2 When using a single holder on a fixture then a single strip can be used for intensity verification. This strip should, ideally, be exposed for the time T derived from the saturation curve and its arc height should be within the stated tolerance band. In practice this is not always possible (for example when integral values of strokes or rotations are used). The nearest practicable time to T should then be used. The arc heights obtained must repeat the value from the saturation curve ±0.038 mm (0.0015 in) or other value acceptable to the customer.

7.3 Using multiple holders on a fixture will produce multiple saturation times (T). To simplify the intensity verification procedure a single verification exposure time may be selected. The time selected should be the longest saturation time of the group of holders - or other value acceptable to the customer. The arc height values at this selected time on each of the corresponding original saturation cruves is called a “target arc height”. The resulting arc height readings must then repeat the value achieved in the corresponding original saturation curve ±0.038 mm (±0.0015 in). The resultant arc height readings do not have to be within the intensity tolerance band since the single verification time at a given location may be substantially less than or greater than T. The purpose of the verification Almen strip is to confirm that the arc height response at a particular location is consistent. The ability of the Almen strip to exhibit similar curvature for similar exposure time is deemed to be sufficient evidence of consistency.

8. NOTES

8.1 Individual Almen strip readings are “arc heights,” not “intensity.” Therefore, exposing a single Almen strip is only to be used for intensity confirmation. Intensity can only be determined by the procedure described in Section 5.

8.2 “Existing process plans with intensity derived by “10% or less” or other approved methods may continue to be used.

8.3 Marginal Indicia

A change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

PREPARED BY THE SAE SURFACE ENHANCEMENT COMMITTEE