SAE Aerospace
An SAE International Group

AEROSPACE MATERIAL SPECIFICATION

SAE AMS2580 | REV. A

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Superseding AMS2580

Shot Peening, Ultrasonically Activated

RATIONALE

AMS2580A clarifies the frequency of intensity verification (4.2.1).

1. SCOPE

1.1 Purpose

This specification covers the requirements for inducing compressive residual stresses on the surface of metal parts using ultrasonically activated shot peening.

1.2 Applications

Ultrasonically activated shot peening is typically used to induce compressive residual stresses on the surface layer of metallic parts to a depth up to 0.040 inch (1 mm). The shape and depth of the compressive residual stress distribution depend on the properties of the part and the ultrasonically activated shot peening process parameters. The residual stresses produced increase fatigue performance, resistance to stress-corrosion cracking, corrosion fatigue, and fretting fatigue, but its usage is not limited to such applications.

2. APPLICABLE DOCUMENTS

The issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been cancelled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 SAE Publications

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

AMS2431	Peening Media (ASR), Cast Steel Shot, Regular Hardness (45 to 52 HRC)
AMS2585	Shot Peening Media, Ultrasonically Activated
SAE J442	Test Strip, Holder and Gage for Shot Peening
SAE J443	Procedures for Using Standard Shot Peening Test Strip
SAE J2277	Shot Peening Coverage
SAE HS-784	Residual Stress Measurement by X-Ray Diffraction

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
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SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/AMS2580A

3. TECHNICAL REQUIREMENTS

3.1 Peening Media

3.1.1 As-received peening media shall conform to the requirement of AMS2585, Shot Peening Media, Ultrasonically Activated.

3.1.2 Other peening media in accordance with AMS2431 may be used with approval by the cognizant engineering organization.

3.1.3 Once the media size, material, hardness, and amount are selected, it shall not be changed without prior approval by the cognizant engineering organization

3.1.4 Each peened part lot shall have a unique media batch and once a batch is prepared for a peened part lot, it shall be treated as a single entity for the life of the batch. Each media batch shall have a log sheet to document accumulated time with respect to amount, size, broken and deformed content.

3.1.5 The media batch shall be totally discarded and replaced with a new one if at least one ball is broken, or if balls are lost or deformed over the established limits. The media batch shall also be totally discarded and replaced with a new one if it has been used for more than the prescribed usage time.

3.1.6 Dilution of a batch with additional shot to improve conditions is not permitted. Mixing of types or sizes of media is also not permitted.

3.2 Equipment

The ultrasonically activated shot peening equipment shall provide a means of transferring kinetic energy to the treatment balls inside a treatment chamber using a metallic element vibrating at an ultrasonic frequency.

3.2.1 Chambers

Chambers are considered part of the process and shall be documented for each application as follows:

3.2.1.1 Each chamber shall have a serial number assigned and shall be part of a source tool control system or alternative system approved by the cognizant engineering organization. Chamber material shall be suitably chosen to limit abrasion which occurs during the peening process. Hard plastic materials with low damping coefficients and heat treated hard steel are suggested as chamber material.

3.2.1.2 Chamber design shall not have any features to trap shots. Chamber ball tightness shall be less than one half of the media diameter used in the chamber.

3.2.2 Sonotrode

The sonotrode is the metallic element vibrating at an ultrasonic frequency that transfers kinetic energy to the treatment balls inside a treatment chamber. Sonotrode is considered part of the process and shall be detailed for each application as follows.

3.2.2.1 Once the sonotrode material, hardness, size and shape are selected, they shall not be changed without prior approval by the cognizant engineering organization.

3.2.3 Parameter Monitoring

The equipment shall be continuously monitored with devices such as PLC or computer to ensure the parameters shown in Table 1 are within the tolerances indicated.

TABLE 1 - PARAMETERS FOR ULTRASONICALLY ACTIVATED SHOT PEENING

Paragraph	Parameter	Units	Process Tolerance Plus or Minus
3.2.3.1	Sonotrode vibration Amplitude	Inch (millimeter)	0.00016 (0.004)
3.2.3.2	Frequency	Hz	400
3.2.3.3	Part Translation	% Inch/min	2
3.2.3.4	Part Rotation	% Revolution/min.	2
3.2.3.5	Peening Cycle Time	Seconds	1

3.2.4 The equipment shall be capable of interrupting the peening cycle within one second, when detected tolerances for amplitude (3.2.3.1), frequency (3.2.3.2), part translation (3.2.3.3) or part rotation (3.2.3.4) are exceeded. The peening system shall also retain in memory any abort details for the parameters listed in Table 1 and be able to resume operation to complete the balance of the process cycle, from the position of shut down, once the out-of-tolerance condition has been corrected. Parts processed during an aborted cycle shall be so identified by the processor.

3.2.5 Gages used with standard “A”, “C”, and “N” test strips shall conform to SAE J442 with end stops.

3.2.6 Blocks and fixtures used to support standard test strips during tests to establish specified peening intensity shall conform to SAE J442. Test strips may also be supported directly on a scrap part or a representative fixture, without separate blocks, as long as the clamping dimensions conform to SAE J442. Alternative thickness of blocks shall be approved by the cognizant engineering organization.

3.2.7 Masks and baffles shall be provided as required to direct shots or beads where desired and to prevent peening in prohibited areas.

3.3 Process Controls

3.3.1 Process tolerance values shall be approved by the cognizant engineering organization.

3.3.2 Almen intensity determination shall conform to SAE J443.

3.3.3 Almen test strips shall conform to SAE J442.

3.3.3.1 In locations where standard test strips cannot be placed to accurately reflect the peening intensity, shaded (or masked) test strips may be used; such strips shall conform to all requirements of SAE J442. The relationship between the peening intensity on the masked test strips and that on the standard test strip shall be established. The arc height thus measured for the masked test strip shall be used to establish a saturation curve for control of the peening intensity.

3.3.3.2 The use and designation of types of test strips will largely depend on the specific results desired. In general, the “A” test strip is used except for high and low intensities. The “C” test strip is usually used if the arc height on the “A” test strip would exceed 0.024 inch (0.61 mm), the “N” test strip is usually used if the arc height on the “A” test strip would be less than 0.004 inch (0.10 mm).

3.3.3.3 Reuse of Almen test strips is not permitted.

3.3.4 Residual stress profiles

3.3.4.1 In some circumstances, where Almen strip measurements cannot be performed, a coupon made of the same material as the part may be used to characterize the peening.

3.3.4.2 Residual stress profile shall be established using the following parameters:

- Superficial residual stress value
- Value and depth of maximum stresses
- Depth where stresses became tensile stresses

3.3.4.3 Residual stress measurement methods shall be suitably chosen to characterize the peening coupon. If the material chosen is not suitable to the method, a similar material can be used and shall be approved by the cognizant engineering organization.

3.3.4.4 Residual stress measurements shall be performed in accordance with SAE HS-784, Residual Stress Measurement by X-Ray Diffraction.

3.4 Preparation

3.4.1 Parts shall be adequately cleaned prior to peening.

3.4.2 Dimensions and surface finishes shall be as specified by the drawing prior to shot peening unless otherwise specified.

3.4.3 All straightening and forming shall be completed prior to peening.

3.4.4 Heat treatment that requires temperatures above those in 3.5.3 shall be completed prior to peening.

3.4.5 All machining of areas to be peened shall be completed, all filets shall be properly formed, all burrs shall be removed, all edges and corners shall be chamfered or/and rounded and roughness shall be as specified prior to peening.

3.4.6 When magnetic particle or fluorescent penetrant inspection is required, parts shall be subjected to such inspection before being peened

3.5 Procedure

3.5.1 Coverage and Appearance

Surfaces that have been peened shall show completed coverage as defined in SAE J2277. If the percent coverage is not specified on the engineering drawing, complete coverage is required.

3.5.2 Peening intensity shall be as specified on the engineering drawing, determined in accordance with SAE J443.

3.5.3 Tolerances

Unless otherwise specified, variation from the specified (minimum) peening intensity shall be -0, +30% to the nearest unit but in no case less than three: thus a specified peening intensity of 6A denotes an arc height of 0.006 to 0.009 inch (0.15 to 0.23 mm) on the “A” specimen and a specified peening intensity of 18N denotes an arc height of 0.018 to 0.023 inch (0.46 to 0.58 mm) on the “N” specimen. Unless otherwise specified, the variation is boundaries of areas to be peened shall be -0 to +0.125 inch (-0 to +3.18 mm) into the area not required to be peened.

3.5.4 The phrase “peening optional” shall mean that peening on areas so indicated is optional and may have complete, partial or no coverage

3.5.5 Areas designated not to be peened may either be masked from peening or they may be peened if subsequent machining operations remove the effect of peening on such areas.

3.5.6 Tolerance

When the masking tolerance is not indicated on the drawing, tolerances used on dimensions shall be plus 0, minus 0.062 inch (1.57 mm). Masking shall be permanent and reusable except expendable masking may be used for pre-production or development parts when approved by the cognizant engineering organization.

3.5.7 Intensity verification locations shall be as indicated on the drawing. When not specified on the drawing, locations shall be as established by the cognizant engineering organization.

3.5.8 Production peening setups shall use the computer pre-program and the procedure sheet to designate the machine and all the machine settings, fixtures, and locations of part and fixtures. Intensity verification using test strips is required by peening a single set of test strips after all monitored parameters, fixtures and locations match the computer pre-program and the procedure sheet. If any strips do not fall within required intensity range, the setup shall be corrected and a new set of strips shall be peened.

3.5.9 Part Holding Fixture

The part shall be held in a fixture designed to rotate and/or translate the part on its axis. The fixture shall be numbered and recorded on the peening procedure sheet. See 4.4.3.

3.6 Post-Peening Treatment

3.6.1 After peening and removal of protective masks, all shot shall be removed from surfaces of parts by a method that will not erode or scratch surfaces.

3.6.2 Straightening of peened parts is prohibited, unless otherwise specified.

3.6.3 Subsequent processing shall be performed only when permitted by the engineering drawing requirements. In order to minimize reduction of the residual stresses imposed by peening, the temperature of the parts caused by such processing shall not exceed the limits of Table 2. See 8.3.2.

TABLE 2 – MAXIMUM TEMPERATURE OF PEENED PARTS

Alloy	Temperature
Alloy Steels	475 °F (246 °C)
Corrosion Resistant Steels	750 °F (399 °C)
Aluminum Alloys	200 °F (93 °C)
Titanium Alloys	475 °F (246 °C)
Magnesium Alloys	200 °F (93 °C)
Nickel and Cobalt Alloys	1000 °F (538 °C)

3.6.4 The amount of metal removed by honing, lapping, or polishing shall be not more than 10% of the specified minimum arc height for “A” and “C” intensities and not more than 3% of the specified minimum arc height for “N” intensities. The removal process shall not produce less compressive residual stress into the part

3.6.5 Peened parts shall be cleaned by suitable method. Halogenated solvents shall not be used to clean titanium alloy parts.

3.6.6 Shot peened parts shall be protected from corrosion during processing and until protective coating or packaging is completed. The method of protection shall be acceptable to the cognizant engineering organization.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection and Process Control

The processor shall supply Almen strips for processors tests and shall be responsible for all required tests. When parts are to be tested, the parts shall be supplied by the purchaser. The cognizant engineering organization reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that processing conforms to specified requirements.

4.2 Classification of Tests

4.2.1 Coverage and appearance (3.4.1) and intensity (3.4.2) are acceptance tests and shall be performed on each lot. Coverage tests shall be performed on representative parts from each lot. Intensity verification shall be performed at the beginning and, for process lot sizes greater than one, at the end of each lot not to exceed eight hours, unless otherwise approved by the cognizant engineering organization.

4.3 Sampling and testing shall be as follows.

4.3.1 Shot maintenance

4.3.1.1 Media

The processor shall maintain a certificate of conformity for the chemical composition of each batch of media.

4.3.1.2 The processor shall have an inspection plan to verify the hardness of each media batch as received.

4.3.1.3 The media batch leakage amount shall be in accordance with Table 3 tolerances during all processing.

TABLE 3 – PERMISSIBLE MEDIA BATCH LEAKAGE AMOUNT

Original Substantiated Values in Ounces (grams)	Tolerance
under 0.70 (20)	±10%
from 0.70 (20) to 1.41 (40)	±6%
over 1.41 (40)	±4%

Other media amount tolerance values shall be approved by the cognizant engineering organization.

4.3.1.4 The media batch amount shall be measured and recorded before and after peening of each part lot. The media batch amount in the chamber shall be measured and recorded during continuous peening at least every 8 hours. If the part peening time is more than 8 hours controls frequency shall be approved by the cognizant engineering organization

4.3.1.5 The media batch shall be inspected and recorded for deformed and broken content before and after peening of each part lot. The media batch shall be measured and recorded during continuous peening at least every 8 hours. If the part peening time is more than 8 hours controls frequency shall be approved by the cognizant engineering organization

4.3.1.6 The usage time of the media cluster shall be established by testing a representative batch using the shot peening parameters for the specific application. The usage time shall be calculated by dividing the tested time to first degradation of the media by a safety factor not higher than 0.8 and acceptable to the cognizant engineering organization.

4.3.2 Fluorescent tracer shall not be used unless the peening machine is equipped with a system to filter out tracer residues during peening as approved by the cognizant engineering organization.

4.4 Approval

4.4.1 The processor's quality control procedures and/or sample peened parts for each part number shall be approved by the cognizant engineering organization, unless such approval be waived by the cognizant engineering organization.

4.4.2 Processor shall establish for each part number a procedure sheet showing process parameters that will be used for peening production parts. The procedure sheet shall be approved by the cognizant engineering organization prior to initial production peening and prior to peening in accordance with a revised procedure.

4.4.3 Procedure sheets shall include a sketch of the machine setups showing chamber placement and/or relation to the part and the following information:

- Machine identification number
- Fixture identification numbers (Almen strip fixture, part fixture, chamber, masking fixture, etc.)
- Machine frequency (nominal value and tolerances)
- Process amplitude (nominal value and tolerances)
- Shot size, material, and hardness range
- Shot amount (nominal value and tolerances)
- Placement of test strips in relation to the work
- Malfunction shutdown limits
- Speed of work movement in translation and rotation
- Peening Time
- Almen Intensity or required residual stress values
- Coverage

4.5 Records

Procedure sheets, work sheets, computer records, test, and Inspection records shall be kept available for not less than five years. The records shall contain all data necessary to verify conformance to the requirements of this specification.

4.6 Reports

The processor shall furnish with each shipment a report stating that the parts have been processed and tested in accordance with the latest revision specified requirements and that they conform to the acceptance test requirements. This report shall include the purchase order number, lot number, AMS2580A, part number, serial number (if assigned), number of parts, processor's procedure number.

4.7 Retest

If any test strip used in the test of fails to meet the specified requirements, disposition of the parts may be based on the results of one additional test strips for each original nonconforming test strip using the same machine settings. Failure of the additional test strip to meet the specified requirements shall be cause for rejection of the parts represented.