



AEROSPACE MATERIAL SPECIFICATION

SAE AMS2432

REV. D

Issued 1990-01
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Revised 2013-02

Superseding AMS2432C

(R) Shot Peening, Computer Monitored

RATIONALE

This revision was issued as part of the SAE Five Year Review process and standardizes shot peening with AMS2430 and industry practices.

NOTICE ORDERING INFORMATION:

- 1) The following information should be provided to the shot peen processor by the purchaser. If the purchaser does not provide any of the following, the processor shall use the specification provisions herein.
 - a. Purchase order number and revision level
 - b. Part number and revision level
 - c. Part alloy and tensile strength and/or hardness
 - d. Quantity of parts
 - e. AMS2432D
 - f. Media type, hardness, size in accordance with AMS2431. See 3.5.
 - g. Test strip type. See 3.2.2.
 - h. Pre-shot peen cleaning method. See 3.3.
 - i. Intensity requirement. See 3.5 and 3.6.
 - j. Intensity verification locations. See 3.5.
 - k. Coverage requirement. See 3.6.
 - l. Coverage verification method and if use of fluorescent tracer or dye marker inks requires cognizant engineering organization approval. See 3.6 and 4.2.1.1.
 - m. Part locations to be shot peened, free from peening, or peening optional. See 3.6.
 - n. If externally applied forces are permitted on part during processing. See 3.5.
 - o. If purchaser requires approval of the processor's shot peening parameter sheet(s). See 3.7 and 4.3.2.
 - p. If purchaser allows the use of alternative intensity verification methods. See 3.7 and 3.8.1
 - q. Post-shot peen cleaning method: include instruction and procedure to remove iron contamination, if applicable, and if purchaser requires peening processor to perform this operation. See 3.9.
 - r. Part preservation/shipping method. See 3.9 and 5.

1. SCOPE

1.1 Purpose

This specification establishes the requirements for computer monitored shot peening of part surfaces by impingement of media, including metallic, glass, or ceramic shot. Computer monitored peening is intended to provide a method of process observation, traceability, and response for all process input settings, in real time, during the entire peening process to ensure with objective evidence, the desired process outputs. Shot peening in accordance with AMS2432 meets or exceeds the requirements of AMS2430.

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1.2 Application

Shot peening is typically used to induce residual compressive stress in the surface layers of parts, and may be used to increase fatigue strength and resistance to stress-corrosion cracking. Shot peening with computer monitoring is typically used to provide control of the peening process to ensure consistent, repetitive peening coverage and intensity on parts. Computer monitored processing is typically required so that the traceability steps specified herein can be utilized by the design authority to take full credit for the benefits of shot peening in the design life.

- 1.2.1 Related peening processes, such as tumble peening, slurry peening, manual peening, peen forming and straightening, peening for prevention of intergranular corrosion, and peening to produce a surface texture, are beyond the scope of this specification.

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 processor 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, General Requirements
AMS2430	Shot Peening, Automatic
SAE J442	Test Strip, Holder, and Gage for Shot Peening
SAE J443	Procedures for Using Standard Shot Peening Almen Strip
SAE J2277	Shot Peening Coverage Determination

2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM E 18	Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials
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2.3 ISO Publications

Available from International Organization for Standardization, 1, rue de Varembe, Casa postale 56, CH-1211 Geneva 20, Switzerland, Tel. +41 22 749 01 11, www.iso.org.

ISO-10012	Measurement Management Systems
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3. TECHNICAL REQUIREMENTS

The AMS2430 Shot Peening, Automatic specification provides the base requirements for the shot peening provided in this specification and is referenced throughout this document. When the AMS2432 computer monitored shot peening process differs from the AMS2430 process, there are additional requirements listed in this specification. Throughout this document, the acronym "IAW" is used for the meaning: "in accordance with."

3.1 Peening Media: New and in-process media shall be IAW AMS2430.

3.2 Equipment and Materials

3.2.1 Peening Machine

3.2.1.1 The peening machine shall run automatically and may be computer controlled. Peening machines shall be equipped with computers for continuously monitoring and recording the parameters shown in Table 1 within the tolerance indicated. Recording shall be digitally recorded or in hard copy and retained in accordance with 4.4. The machine shall provide a means of propelling, at a controlled rate, dry media with air pressure against the part. Alternatively, metallic media may be propelled by centrifugal force. The machine shall provide a means of moving, at a uniform speed, either the part through the media stream or the media stream over the part in either translation, rotation, or both, as required. The part shall not be subjected to any random movement during the process. The machine shall be capable of consistently reproducing the required shot peening intensities.

TABLE 1 - PARAMETERS FOR PEENING MACHINES

Parameter	Units	Process Tolerances Shutdown Limits Plus or Minus
Shot Flow (for each nozzle)	Pounds/minute (kg/minute)	10%
Air Pressure NOTE 1 (for each nozzle)	psi (kPa)	> 20 psi 10% ≤ 20 psi 20%
Wheel Speed (for each wheel)	rpm	> 2000 rpm 1% < 2000 rpm 20 rpm
Nozzle or Wheel Translation Speed	Inch/minute (mm/minute)	10%
Deflector Speed	Inch/minute (mm/minute)	10%
Nozzle and/or Wheel Shut Down	Seconds	1
Turntable Speed	rpm	10%
Part Speed	rpm/inch/minute (mm/minute)	10%
Conveyor Speed	Inch/Minute (mm/minute)	10%
Peening Cycle Time	Seconds	1
Nozzle/Wheel Position	Inch/degree (mm/degree)	0.062 inch (1.57 mm)/ 5 degrees
Table/Part Indexing	Inch/degree (mm/degree)	0.062 inch (1.57 mm)/ 5 degrees

NOTE 1: On direct pressure and suction systems, air pressure shall be measured at or as close as practical to the nozzle. For gravity type systems, air pressure should be measured down stream of regulator for each nozzle. All gages shall be labeled in accordance with ISO 10012.

- 3.2.1.2 The peening system shall be capable of interrupting the peening cycle within one second, when excursions outside set tolerances are detected for shot flow, air pressure, wheel speed, nozzle and/or wheel translation speed, turntable speed, part speed, or conveyor speed. Excursions outside the limits in Table 1 shall cause an aborted cycle and the computer system shall record the time and abort details for the parameters listed in Table 1. Notation of root cause and corrective action shall be documented. Restarting of the machine shall only be done by authorized personnel. After the out-of-tolerance condition has been corrected, the peening system shall be able to resume operations to complete the balance of the process cycle from the position of shut-down, or restart program from the beginning, Parts processed during to an aborted cycle shall be so identified on the peening certificate and/or computer print-out.
- 3.2.1.3 The machine shall incorporate equipment to extract dust and fine particle contaminants from the in-process media unless the purchaser permits its absence. Peening machine shall be equipped with a shot screening system and shot shape control mechanisms capable of continuously maintaining the quality of the peening media in the machine to meet the requirements of 3.1.

3.2.2 Test Strips

Almen test strips shall conform to SAE J442 except thickness and flatness tolerance shall be ± 0.0005 inch (± 0.013 mm). Mechanically deforming strips to meet the prebowl requirement is not permitted. Usage shall conform to SAE J443.

3.2.2.1 Hardness shall be 73.0 to 74.5 HRA for N strips and 45 to 48 HRC, or equivalent, for other standard strips. Hardness shall be measured in accordance with ASTM E 18 at approximately 0.5 inch (12.7 mm) from either end on the longitudinal center line of a flat side using Rockwell "C" scale, or equivalent, for A and C strips. For N strips, the Rockwell "A" scale, or equivalent, shall be used. Sampling for hardness testing of the strips may be used to minimize hardness tester impressions on the strips.

3.2.2.2 Subsize or otherwise standard shaded or masked test strips shall be in accordance with AMS2430.

3.2.3 Gage

Almen test gages used with standard test strips shall conform to SAE J442 with end stops except that the gages shall have digital readout and have an accuracy of ± 0.0001 inch (± 0.0025 mm). Almen gages shall be zeroed, at a minimum, once daily using a zero block that is flat within 0.0002 inch (0.005 mm). Gages of appropriate design shall be used for arc height measurements of subsized strips.

3.2.4 Test Strip Holder

Almen test strip holder shall be in accordance with SAE J442.

3.2.5 Almen Test Strip Fixture

A test strip fixture will be made from either a scrap part or a representative non-adjustable fixture fitted with test strip holder(s) to mount the test strip(s) for use during the intensity development or intensity verification in accordance with SAE J443. If test strip holders for masked test strips are used, they shall be approved by the cognizant engineering organization. The Almen test strip fixture shall represent the surface to be peened and be rotated or translated in the same manner as the part during the peening process. The design of the Almen strip fixture shall be approved by the cognizant engineering organization. The fixture shall be numbered and recorded in the procedure sheet and shall be used for all subsequent intensity verifications

3.2.6 Machine Verification Tool

For machines that are computer controlled and monitored in accordance with AMS 2432, a machine verification tool is an Almen test strip holder designed to establish process intensity baselines. The tool shall also be used to verify consistent machine performance relative to the baseline during production. The machine verification tool shall be documented on the process parameter sheet and its design and use shall be approved by the cognizant engineering organization.

3.2.7 Nozzle Holding Fixture

When a non-robotic air nozzle peening machine is used, each nozzle shall be held in a fixture so that the angle of impingement and stand-off distance conforms to the process parameter sheet during peening. The nozzle holding fixture, when used, shall be numbered and recorded on the process parameter sheet.

3.2.8 Control Cage

When a centrifugal wheel machine is used, the control cage, which regulates the position and angle of the maximum intensity zone generated by the wheel, shall be set in respect to the part location, so that the angle of impingement of the maximum intensity zone will remain constant to procedure sheet requirements. A reference point on the impeller cage position indicator shall be part of the wheel system. The position of the control cage shall be recorded on the procedure sheet.

3.2.9 Media size inspection equipment

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3.2.10 Media shape inspection equipment

IAW AMS2430.

3.3 Prepeening Preparation

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3.4 Masking

Areas of the part that are designated to be free from any shot peening shall be suitably masked or protected from the peening stream. Unless otherwise specified, the variation in boundaries of the areas to be peened, when limited, shall be -0 to +0.125 inch (-0 to +3.18 mm).

3.5 Peening

IAW AMS2430 and the following:

- 3.5.1 Shot peening locations used for intensity verification (Almen test strip locations), media type, media size and peening intensities shall be as specified by the drawing or established by the cognizant engineering organization. If media size and intensity are not specified, reference the guidelines provided in Table 2. The resulting parameters for process control shall be documented in accordance with 3.7.3.

TABLE 2 - MEDIA SIZE AND INTENSITY GUIDELINES FOR VARIOUS MATERIALS

Material	Material Thickness 0.090 to 0.375 inch (2.29 to 9.52 mm)		Material Thickness Over 0.375 inch (9.52 mm)	
	Shot Size	Intensity, inch (mm)	Shot Size	Intensity, inch (mm)
Titanium Alloys	110, 170	0.006 to 0.010A (0.15 to 0.25A)	110, 170	0.006 to 0.010A (0.15 to 0.25A)
Steel, tensile strength less than 200 ksi (less than 1379 MPa)	230, 330	0.008 to 0.012A (0.20 to 0.30A)	230, 330	0.010 to 0.014A (0.25 to 0.36A)
Steel, tensile strength 200 to 260 ksi (1379 to 1793 MPa)	170, 230	0.008 to 0.012A (0.20 to 0.30A)	230, 330	0.012 to 0.016A (0.30 to 0.41A)
Aluminum	170, 230	0.006 to 0.010A (0.15 to 0.25A)	230, 330	0.010 to 0.014A (0.25 to 0.36A)
Holes: Aluminum alloys under 0.750 inch (19.05 mm) diameter	70, 130	0.010 to 0.015N (0.25 to 0.38N)	--	--
Holes: All other alloys except aluminum under 0.750 inch (19.05 mm) diameter	70, 110	0.010 to 0.015N (0.25 to 0.38N)	--	--

General Notes:

1. Shot size and intensity specified on the part drawing shall take precedence.
2. Shot sizes listed in Table 2 are for ASR (cast steel shot, regular) and ASH (cast steel shot, hard). Equivalent sizes of other media, in accordance with AMS 2431, shall be used when shown on part drawing.
3. For material thickness under 0.090 inch (2.29 mm), see 3.6.2.3.

3.6 Shot Peening Properties (including intensity and coverage requirements)

Shall be in accordance with AMS2430 and the following:

3.6.1 At no time can the test strip arc height measurements during intensity verification fall below the minimum intensity requirement specified on the engineering drawing.

3.6.2 Application to Specific Geometries

IAW AMS2430 and the following.

3.6.2.1 When media size is not specified and two or more thicknesses are present on the same part and one is over 0.375 inch (9.52 mm) and the other is equal to or less than 0.375 inch (9.52 mm) (see Table 2), the part shall be peened as follows, or as otherwise approved by the cognizant engineering organization.

3.6.2.1.1 The thicker area shall be peened using the correct shot size and intensity for that thickness.

3.6.2.1.2 The thinner areas shall be masked at any outside corner where the change of cross-section occurs. Do not mask on an inside radius. If the change of cross-section is gradual, the peening intensity and coverage shall fade within 2.0 inches (51 mm) into the thinner area.

- 3.6.2.1.3 The thinner areas shall next be peened to the correct intensity and shot size with no masking of thicker sections, except as required by the drawing. Full coverage with this second shot size and intensity is required for not less than a 2.0 inch (51 mm) overlap into the area previously peened, or to the limit of the previously peened area if it less than 2.0 inch.
- 3.6.2.2 Peening is optional on inside surfaces of holes and apertures under 0.125 inch (3.18 mm) diameter or width. Peening is optional in blind holes and recesses under 0.5 inch (13 mm) in diameter or width, if depth exceeds diameter or width. Ricochet peening may be used if permitted by the cognizant engineering organization.
- 3.6.2.3 Thin sections under 0.090 inch (2.29 mm) in nominal thickness shall not be peened unless specifically required on the drawing. When peening is required, shot size, intensity, and coverage shall be specified on the drawing.

3.7 Process Parameter Sheet

IAW AMS2430 and the following:

3.7.1 Process development

IAW AMS2430.

- 3.7.2 Shutdown limits for air pressure and shot flow shall be refined during procedure development to ensure conformance to drawing intensity requirements. To establish shutdown limits, two arc height tests shall be conducted at the intensity time, one at a high air pressure limit/low shot flow combination and the other at a low air pressure limit/high shot flow combination. The air pressure and shot flow shutdown limits shall be adjusted until these arc heights are within drawing intensity range and then documented on the process parameter sheet.
- 3.7.3 All shot peening process parameter sheets shall include figures showing the machine and fixture set up with nozzle/wheel relation to the fixture/part and shall document the process parameters shown in Table 3 at minimum:

TABLE 3 - PROCESS PARAMETER SHEET REQUIREMENTS

Process parameter sheet number and date
Purchaser approval date (if required)
Part number (drawing) revision and date
Part material and tensile strength and/or hardness
AMS2432
Intensity requirement
Test strip type (N, A, C) and/or subsize strip information if applicable
Part locations to be shot peened, free from peening, or peening optional
Percent coverage requirement
Media type, hardness, size in accordance with AMS2431
Type of machine
Machine number or serial number
Number of nozzles or wheels
Size of nozzles or wheels
Size of metering orifice (pneumatic machine only, if metered)
Nozzle or slinger position and/or angle of impingement
Nozzle holding fixture (if applicable)
Centrifugal wheel machine control cage position and angle with respect to part (if applicable)
Centrifugal wheel machine control cage position of intensity zone (if applicable)
Media flow rate
Air pressure and/or wheel speed
Shot velocity (if applicable)
Nozzle (or wheel) -to-part distance (stand-off distance)
Speed of nozzle and or part movement in translation and rotation
Part holding and/or masking fixture
Intensity verification fixture
Intensity verification locations
Machine verification tool or velocity sensor (if applicable)
Machine shut down limits
Saturation curve data
Pre-shot peen cleaning method
Part masking
Coverage time or passes for specified area
Coverage inspection method-visual examination only, or fluorescent tracer or dye marker inks, and customer approval if required.
Post-shot peen cleaning method
Part preservation/shipping method

3.8 Production Part Peening

IAW AMS2430 and the following:

- 3.8.1 An alternative intensity verification method, such as use of a machine verification tool or media velocity sensor, for production part peening may be used only if approved by the cognizant engineering organization. The control method and frequency shall be complied with as documented on the process parameter sheet.

3.9 Post-Peening Processes

IAW AMS2430 and the following:

3.9.1 When surface finish or dimensions after peening do not meet drawing requirements, they may be corrected, with cognizant engineering approval, by a second peening operation at a lower intensity. Alternatively, unless material removal is prohibited, they may be corrected by one or more of the following: polishing, lapping, honing, or sanding. If material removal is selected, evidence of peening impressions shall remain after material removal. Grinding or etching shall not be used unless approved by the cognizant engineering organization.

3.10 Tolerances

IAW AMS2430.

3.11 Test Methods

IAW AMS2430.

4. QUALITY ASSURANCE PROVISIONS

4.1 Inspection and Process Control

IAW AMS2430.

4.2 Classification of Tests

IAW AMS2430.

4.2.1 Acceptance Tests

IAW AMS2430 and the following:

4.2.1.1 Impact Sensitive Fluorescent or Dye Marker Coatings

When used, shall be applied in accordance with manufacturer's instructions. After initial coverage is verified, coating of entire part may be reduced to critical areas with cognizant engineering organization approval.

4.2.1.2 For aluminum parts having large plan form surfaces (such as wing-skins), the areas outside of the Almen strip locations may be examined for coverage with the unaided eye.

4.2.1.3 Periodic tests

IAW AMS2430 and the following:

4.2.1.4 Almen gage zeroing is a periodic test shall be performed, at a minimum, once daily.

4.3 Preproduction Requirements and Testing

4.3.1 Quality Control

4.3.1.1 Aerospace Applications

The processor's quality control system and compliance to this specification shall be approved by the cognizant quality assurance organization before aerospace parts for production use are supplied. Facilities performing computer controlled shot peening in accordance with this specification shall be approved by the cognizant quality assurance organization.

4.3.1.2 Non-Aerospace Applications

Cognizant quality assurance organization approval of the processor's quality control system and compliance to this specification is not required for non-aerospace parts unless specifically invoked by purchase order, specification or drawing.

- 4.3.2 Qualification of the peening process parameter sheet and part set up in accordance with 3.7 is a preproduction test and shall be performed prior to part production and when the cognizant engineering organization requires confirmatory testing. The process parameter sheet shall be approved by the cognizant engineering organization prior to initial production peening and prior to peening with a revised procedure.
- 4.3.3 The computer monitoring system shall be checked for proper shut down and process parameter sheet documentation.
- 4.3.4 The processor's equipment used for measuring the shot peening results and process parameters (e.g. - Almen gages, shot flow/metering devices, air pressure gages and transducers, equipment movement sensors, etc.) shall be calibrated as required per the processor's quality requirements or at least every 12 months. Calibration in accordance with ISO-10012 shall be against instruments whose calibration is traceable to National Institute of Standards and Technology (NIST) or other nationally accredited standards organization approved by the cognizant engineering organization.

4.3.5 Training requirements

IAW AMS2430.

4.3.6 Re-testing and corrective action

IAW AMS2430.

4.4 Records

Process parameter sheets, computer records (3.2.1.1), test, and inspection records shall be kept available for not less than 5 years, unless a longer retention period is required by the purchaser. The records shall contain all data necessary to verify conformance to the specified requirements. The Almen test strip measurements shall be documented by process parameter sheet location for traceability.

4.5 Reports

The processor shall furnish with each shipment a report stating that the parts have been processed and tested in accordance with the specified requirements and that they conform to the acceptance test requirements. This report shall include the purchase order number, AMS2432D, part number, lot identification, and quantity.

5. PREPARATION FOR DELIVERY: IAW AMS2430.

6. ACKNOWLEDGMENT

The processor shall mention AMS2432 and its revision letter in all quotations and when acknowledging purchase orders.

7. REJECTIONS

Parts on which peening does not conform to this specification, or to modifications not authorized by purchaser, will be subject to rejection.

8. NOTES

- 8.1 A change bar (|) 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.

8.2 Terms used in AMS are clarified in ARP1917, IAW AMS2430, and as follows.

8.2.1 Computer Monitored

The combined use of sensors and computers to track in real time the operating parameters of the peening equipment, and to shut down the equipment in case of any deviation from the process parameter sheet settings. The monitored parameters can be reported on paper, or computer file, or other method approved by the cognizant engineering organization.

8.3 Dimensions and properties in inch/pound units and the Fahrenheit temperatures are primary; dimensions and properties in SI units and the Celsius temperatures are shown as the approximate equivalents of the primary units and are presented only for information.

8.4 Shot Peening Design Guidelines should be in accordance with AMS2430.

PREPARED BY AMS COMMITTEE "B" AND AMEC-SE