

AEROSPACE MATERIAL SPECIFICATION

(R) Shot Peening, Automatic

1. SCOPE:

1.1 Form:

This specification covers the engineering requirements for automatic peening of surfaces of parts by impingement of metallic shot, glass beads, or ceramic shot.

1.2 Application:

To induce residual compressive stress in surface layers of parts, thereby increasing fatigue strength and resistance to stress-corrosion cracking but 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, 400 Commonwealth Drive, Warrendale, PA 15096-0001 or www.sae.org.

AMS 2431	Peening Media, General Requirements
SAE J442	Test Strip, Holder and Gage for Shot Peening
SAE J443	Procedure for using Standard Shot Peening Test Strip
SAE J2277	Shot Peening Coverage

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2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshocken, PA 15428-2959 or
www.astm.org

ASTM E 18 Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials
ASTM E 11 Wire Cloth and Sieves for Testing Purposes

3. TECHNICAL REQUIREMENTS:

3.1 Peening Media:

3.1.1 Peening Media: As-received peening media shall conform to the requirements of AMS 2431.

3.1.1.1 New cast steel shot shall be conditioned to remove scale before being used for peening parts.

3.1.2 Media Maintenance:

3.1.2.1 Media size uniformity during processing shall be in accordance with Table 1. Inspection shall be conducted in accordance with 4.3.3.

TABLE 1 - Size Uniformity Requirements of Shot in Machine

Cast Shot Sizes ASR or ASH ¹	Cut Wire Sizes AWCR, AWS, or AWCH ¹	Glass Bead Sizes AGB ¹	Ceramic Shot Sizes AZB ¹	0.5% Maximum By weight allowed to be Retained on US Sieve ² , Size mm (Inch)	Maximum 20% By Weight Passing US Sieve ² , Size mm (Inch)
930	—	—	—	5, 4.00 (0.157)	8, 2.36 (0.0937)
780	—	—	—	6, 3.35 (0.132)	10, 2.00 (0.0787)
660	—	200	—	7, 2.80 (0.110)	12, 1.7 (0.0661)
550	62	170	—	8, 2.36 (0.0937)	14, 1.4 (0.0555)
460	54	140	—	10, 2.00 (0.0787)	16, 1.18 (0.0469)
390	47	—	—	12, 1.7 (0.0661)	18, 1.00 (0.0394)
330	41	100	850	14, 1.4 (0.0555)	20, 0.850 (0.0331)
—	35	—	—	14, 1.4 (0.0555)	20, 0.850 (0.0331)
280	32	—	—	16, 1.18 (0.0469)	25, 0.710 (0.0278)
230	28	70	600	18, 1.00 (0.0394)	30, 0.600 (0.0234)
190	23	—	—	20, 0.850 (0.0331)	35, 0.500 (0.0197)
170	20	50	425	25, 0.710 (0.0278)	40, 0.425 (0.0165)
130	17	—	—	30, 0.600 (0.0234)	45, 0.355 (0.0139)
110	14	35	300	35, 0.500 (0.0197)	50, 0.300 (0.0117)
—	—	30	—	40, 0.425 (0.0165)	60, 0.250 (0.0098)

¹See AMS 2431 for definitions

²Sieve specified in ASTM E11

TABLE 1 - Size Uniformity Requirements of Shot in Machine (Continued)

Cast Shot Sizes ASR or ASH ¹	Cut Wire Sizes AWCR, AWS, or AWCH ¹	Glass Bead Sizes AGB ¹	Ceramic Shot Sizes AZB ¹	0.5% Maximum By weight allowed to be Retained on US Sieve ² , Size mm (Inch)	Maximum 20% By Weight Passing US Sieve ² , Size mm (Inch)
70	12	—	—	40, 0.425 (0.0165)	80, 0.180 (0.0070)
—	—	25	210	45, 0.355 (0.0139)	70, 0.212 (0.0083)
—	—	18	150	60, 0.250 (0.0098)	100, 0.150 (0.0059)
—	—	15	—	70, 0.212 (0.0083)	120, 0.125 (0.0049)
—	—	12	—	80, 0.180 (0.0070)	140, 0.106 (0.0041)
—	—	9	—	120, 0.125 (0.0049)	200, 0.075 (0.0029)
—	—	6	—	170, 0.090 (0.0035)	270, 0.055 (0.0021)

¹See AMS 2431 for definitions²Sieve specified in ASTM E11

3.1.2.2 Media Shape Maintenance: Media shape uniformity during processing shall meet the requirements of Table 2A and 2B.

TABLE 2A - Non-Metallic Media Shape Uniformity Maintenance Requirements

Sample Size (Inches)	Glass Bead Sizes AGB	Max Allowable Number of Unacceptable Glass Bead Shapes (5%)	Ceramic Shot Sizes AZB ¹	Max Allowable Number of Unacceptable Ceramic Shot Shapes (5%)
1 x 1	200	14	—	—
1 x 1	170	19	—	—
1 x 1	140	28	—	—
½ x ½	100	14	850	14
½ x ½	70	28	600	28
¼ x ¼	50	14	425	14
¼ x ¼	35	28	300	28
¼ x ¼	30	40	—	—
1/8 x 1/8	25	14	210	14
1/8 x 1/8	18	28	150	28
1/8 x 1/8	15	40	—	—
1/8 x 1/8	12	57	—	—
1/8 x 1/8	9	122	—	—
1/8 x 1/8	6	240	—	—

¹See AMS 2431 for definitions

TABLE 2B - Metallic Media Shape Uniformity Maintenance Requirements
(values chosen to represent approximately 5% of sample)

Sample Size (Inches)	Cast Shot Sizes ASR or ASH ¹	Maximum Allowable Number of Unacceptable Cast Shot Shapes (5%)	Cut Wire Sizes AWCR, AWS, AWCH ¹	Maximum Allowable Number of Unacceptable Cut Wire Shapes (5%)
1 x 1	930	4	—	—
1 x 1	780	5	—	—
1 x 1	660	7	—	—
1 x 1	550	9	62	12
1 x 1	460	16	54	16
1 x 1	390	22	47	22
½ x ½	330	7	41	28
½ x ½	—	—	35	9
½ x ½	280	9	32	11
½ x ½	230	14	28	14
½ x ½	190	22	23	22
½ x ½	170	31	20	31
¼ x ¼	130	9	17	9
¼ x ¼	110	14	14	14
¼ x ¼	70	22	12	20

¹See AMS 2431 for definitions

3.1.2.3 Glass beads and ceramic shot shall be inspected in accordance with 4.3.3 to ensure that not more than 10% (by number) of the beads or shot are broken. When wet glass bead is used, the entire slurry charge shall be changed at frequent intervals for compliance with this requirement. Fresh beads may be added only once between changes of the entire slurry to maintain the media quality.

3.2 Equipment:

The following types of equipment shall be provided for the peening of parts

3.2.1 Peening Machine:

3.2.1.1 Pneumatic and centrifugal peening machines shall be used to peen parts. Nozzle positions of pneumatic machines or wheel cages of centrifugal machines shall be adjusted so those peening streams have an angle of impingement as nearly perpendicular as practicable to areas to be peened. Air pressure or wheel speeds shall be adjusted to yield designated intensities.

- 3.2.1.2 The peening machine shall provide means of propelling, at a controlled rate, dry metallic shot by air pressure or centrifugal force, or propelling dry or wet glass beads or ceramic shot by air pressure, against the work, and means of uniformly moving the work through the shot or bead stream in either translation, rotation, or both as required. The nozzles and the work shall be held and moved mechanically.
- 3.2.1.3 Unless otherwise specified, equipment for dry peening with either shot or beads shall include a separator for shape control and contaminant removal. The separator shall provide means for continuous removal of broken or defective shot or beads during peening. For wet bead peening, a separator is not required but the entire slurry shall be changed often enough that the peening intensity under any given set of parameters remains within established limits for that set of parameters. Fresh beads may be added once between changes of the entire slurry to maintain the peening intensity.
- 3.2.1.4 Each set up shall be qualified for each part number. Either a scrap piece or representative fixture shall be fitted with sufficient test strip holders oriented essentially in the same manner, with the same surrounding features as the part, to represent the actual designated surface. Peening time and a saturation curve shall be established for each Almen test strip.
- 3.2.2 Almen Test Strips: Almen test strips shall conform to SAE J442.
- 3.2.2.1 In locations where standard test strips cannot be placed to accurately reflect the peening intensity, shaded (or masked) test strips may be used; such test strips shall conform to all requirements of 3.2.2 The relationship between the peening intensity on the masked test strips and that on the standard test strip shall be established. The intensity thus established for the masked test strip shall be used for control of the peening intensity.
- 3.2.2.2 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).
- 3.2.2.3 Reuse of test strips for determining intensity is prohibited.
- 3.2.3 Gages used with standard "A", "C", and "N" test strips shall conform to SAE J442 with end stops.
- 3.2.4 Blocks or Fixtures: Blocks or 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 the scrap piece or representative fixture, without separate blocks, as long as the clamping dimensions conform to SAE J442.
- 3.2.5 Masking: Suitable masks and baffles shall be provided to direct the shot or beads where desired and to prevent peening in prohibited areas.

3.3 Preparation:

The following preparatory steps shall be completed prior to peening of parts.

3.3.1 Preparation of Parts: Parts shall be free of grease, dirt, oil, corrosion, and corrosion-preventive coatings such as anodic coatings, plating, or paint. Areas of the part or workpiece which are designated to be free from any shot peening marks shall be suitably masked or otherwise handled to protect such surfaces from the peening stream or subsequent damage. When it is impractical to mask or otherwise protect areas designated to be free from shot peening marks, sufficient stock shall be provided in these areas for subsequent removal of affected material for compliance with dimensional requirements of the applicable drawing.

3.3.1.1 All heat treatment to meet requirements for mechanical properties shall be completed prior to peening.

3.3.1.2 All machining of areas to be peened shall be completed, all fillets shall be properly formed, all burrs shall be removed, and edges and corners to be peened shall be rounded.

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

3.4 Procedure:

3.4.1 Parts shall be peened on all areas specified on the engineering drawing. If the drawing does not specify the areas, the parts shall be peened on all surfaces except in holes and apertures smaller than 0.50 inch (13 mm) in diameter or width. If these small areas require shot peening, the drawing shall so designate.

3.4.2 The phrase "peening optional" shall mean that peening on areas so indicated is optional and may have complete, partial, or no coverage.

3.4.3 Areas specified not to be peened may either be masked from the peening stream or they may be peened if subsequent machining operations remove the effects of peening on such areas.

3.4.4 If fillet radii on parts are required to be peened, the shot or bead size used shall be such that the shot or bead nominal diameter is not greater than one-half the smallest nominal fillet radius to be peened, except that the nominal diameter of the shot need not be smaller than 0.007 inch (0.18 mm) and the nominal diameter of beads need not be smaller than 0.002 inch (0.05 mm). If the shot or beads must pass through recesses or apertures to peen required surfaces, the nominal diameter of the shot or beads shall be not greater than 25% of the width of the opening, except that the limitations as to minimum shot and bead size specified above for peening fillets shall also apply.

3.4.5 If the percent coverage is not specified on the engineering drawing, complete coverage shall be used.

3.5 Post Treatment:

- 3.5.1 After peening and removal of protective masks, all shot or beads and fragments there from shall be removed from surfaces of parts by a method which will not erode or scratch surfaces.
- 3.5.2 Straightening of peened parts is prohibited, unless otherwise specified.
- 3.5.3 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 3.

TABLE 3 - Temperature Limits for Peened Parts

Alloy	Temperature
Low-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)

- 3.5.3.1 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.
- 3.5.4 Aluminum alloy, magnesium alloy, corrosion resistant steel alloy, and titanium alloy parts which have been steel shot peened shall be cleaned by suitable methods to remove all iron contaminants. Halogenated solvents shall not be used to clean titanium alloy parts.
- 3.5.5 Shot peened parts shall be protected from corrosion during processing and until protective coating or packaging is completed. The method of protection shall be as acceptable to the cognizant engineering organization.
- ### 3.6 Properties:
- 3.6.1 Coverage and Appearance: Surfaces which have been peened shall show complete coverage as defined in SAE J2277.
- 3.6.2 Intensity: Peening intensity shall be as specified on the engineering drawing, determined in accordance with SAE J443.

3.7 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 in 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.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

The processor shall supply all samples for processors tests and shall be responsible for the performance of all required tests. When parts are to be tested, the parts shall be supplied by purchaser. Purchaser 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 Acceptance Tests: Coverage and appearance (3.6.1) and intensity (3.6.2) 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 lot sizes greater than one, at the end of each lot or every eight hours, whichever is less.

4.2.2 Periodic Test: Shot maintenance (3.1.2) is a periodic test and shall be performed at the frequency specified in 4.3.3.

4.2.3 Preproduction Test: Qualification of peening set up (3.2.1.4) is a preproduction test.

4.3 Sampling and Testing:

Shall be as follows; a lot shall be all parts in a production run that are peened in one setup of the machine using the same test piece fixture and the same peening parameters and in increments of not more than eight hours of machine operation (actual peening time).

4.3.1 Coverage and Appearance: Parts shall be inspected for coverage and appearance by methods defined in SAE J2277.

4.3.2 Intensity:

4.3.2.1 The intensity shall be verified by peening one strip at saturation time "T" at each verification point as specified in 4.2.1.

4.3.3 Shot Maintenance:

4.3.3.1 Machines with Built-In Screen Classifiers: Shot size and shape shall be inspected in accordance with Table 4 or whenever the size or type of media in the machine is changed. Peening intensity verification must be performed whenever the media maintenance requirements are violated.

4.3.3.2 Machines without Classifiers: Shot size and shape shall be inspected in accordance with Table 4 or whenever the size or type of media in the machine is changed. Peening intensity verification must be performed whenever the media maintenance requirements are violated.

TABLE 4 - Media Maintenance Inspection Frequency Requirements

Media	Machine With Classifier (Hrs)	Machine Without Classifier (Hrs)
AMS 2431 /1 Cast Steel Shot Regular	40	8
AMS 2431 /2 Cast Steel Shot Hard	40	8
AMS 2431 /3 Cut Wire Shot Carbon, Regular	80	16
AMS 2431 /4 Cut Wire Shot Stainless	120	24
AMS 2431 /5 Peening Balls	20	4
AMS 2431 /6 Glass Bead	8	2
AMS 2431 /7 Ceramic Bead	8	4
AMS 2431 /8 Cut Wire Shot Carbon, Hard	80	16

4.4 Approval:

4.4.1 The processor's quality control system and compliance to this specification shall be approved by the cognizant authority before parts for production use are supplied. Peen operators shall be trained and demonstrate proficiency in setup of nozzles and fixturing, setting machine parameters, intensity verification and determination of shot quality.

4.4.2 Processor shall establish, for each part number, parameters for control factors for processing which will produce acceptable peened parts; these shall constitute the approved peening procedures and shall be used for peening production parts. If necessary to make any change in parameters for critical items of processing, processor shall submit for approval a revised peening procedure and, when requested, sample peened parts. Production parts peened by the revised procedure shall not be shipped prior to receipt of reapproval.

- 4.4.2.1 Control factors must be recorded. Process variables shall include, but are not limited to, the following:

- Type of machine (pneumatic or centrifugal)
- Number of nozzles or wheels
- Size of nozzles or wheels
- Nozzle or slinger position
- Air pressure or wheel speed in rpm
- Nozzle (or wheel) -to-work distance (or control program reference number)
- Media type, hardness, size. See AMS 2431
- Speed of work movement in translation and rotation
- Placement of test strips in relation to the work
- Time to peen part
- Size of metering orifice (pneumatic machine only)
- Test strip type (A,N,C)
- Holding and masking fixture
- Intensity
- Percent Coverage

- 4.4.2.1.1 Any of the above control factors for which parameters are considered proprietary by the processing vendor may be assigned a code designation. Each variation in such parameters shall be assigned a modified code designation.

4.5 Test Methods:

4.5.1 Coverage: Shall be determined in accordance with SAE J2277.

4.5.2 Intensity: Shall be determined in accordance with SAE J443.

4.6 Reports:

The processor shall furnish with each shipment a report stating that the parts have been processed and tested in accordance with latest revision specified requirements and that they conform to the acceptance test requirements. This report shall include the purchase order number, lot number, AMS 2430M, part number, serial numbers (if assigned), number of parts, processor's procedure number.

4.7 Retest:

If any test strip used in the test of 4.5.2 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.

5. PREPARATION FOR DELIVERY:

5.1 Packaging and Identification:

5.1.1 Peened parts shall be handled and packaged to ensure that the required physical characteristics and properties of the peened parts are preserved.

5.1.2 Packages of peened parts shall be prepared for shipment in accordance with commercial practice and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the parts to ensure carrier acceptance and safe delivery.

6. ACKNOWLEDGMENT:

The processor shall mention AMS 2430 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 required by purchaser, will be subject to rejection with subsequent disposition determined by purchaser.

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 a specification. An (R) symbol to the left of the document title indicates a complete revision of the specification, including technical revision. Change bars and (R) are not used in original publications, nor in specifications that contain editorial changes only.

8.2 Engineering Drawings should specify:

8.2.1 Shot peening in accordance with AMS 2430.

8.2.2 Defined peening conditions such as:

- Areas to be peened
- Media type, size (and hardness)
- Almen intensity
- Location of Almen intensity verification
- Areas to be masked
- Areas where peening is optional

8.3 Intensity ranges for various media types.

8.3.1 Metallic shot may be used for peening to intensities requiring use of "N", "A" or "C" Almen test strips.

- 8.3.2 Glass beads may be used for peening to intensities requiring use of "N" or "A" Almen test strips.
- 8.3.3 Ceramic shot may be used for peening to intensities requiring use of "N" or "A" Almen test strips.
- 8.4 Dimensions in inch/pound units and the Fahrenheit temperatures are primary; dimensions in SI units and Celsius temperatures are shown as the approximate equivalents of the primary units and are presented only for information.

- 8.5 Purchase documents should specify not less than the following:

AMS 2430M

Part number of parts to be peened
Quantity of parts to be peened
Peening intensity desired.

- 8.6 Definitions:

Automatic: a class of peening machine that precludes use of manual movement of either the shot stream or the workpiece but relies upon mechanical means to provides these features.

Cognizant Engineering Organization: the responsible authority or entity responsible for approving specification or drawing departures and interpretations.

Media: any of the commonly used materials used for peening, such as cast steel shot, cut wire shot, ceramic bead, glass bead, or peening balls. See AMS 2431.

Nominal Size: approximate size of media in ten-thousandths of inch. Example: S-110 = 0.011 inch. Used in determining minimum fillet radius requirements. The size of the media maintenance screen opening for 20% Passing.

- 8.7 Terms used in AMS are clarified in ARP1917.

- 8.8 Key Words:

Metallic shot, glass shot, ceramic shot, surface stress inducement, Almen gage, Almen test strip, cast steel shot, ceramic bead, cut wire shot, fatigue strength, fluorescent tracer system, glass bead, peening intensity, saturation curve, shot peening, shot size, surface stress inducement, stress corrosion resistance

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