SAE Aerospace
An SAE International Group

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 2432C

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Superseding AMS 2432B

Shot Peening, Computer Monitored

RATIONALE

This revision was issued as part of the SAE Five Year Review process.

1. SCOPE

1.1 Purpose

This specification establishes the requirements for computer-monitored peening of parts surfaces.

1.2 Application

This procedure is used typically to provide a means by which the shot peening process can be performed repeatedly on parts in order to satisfy material component design requirements, but usage is not limited to such applications.

1.3 Shot peening locations used for intensity verification (Almen test strip locations), media type, media size and peening intensities shall be as specified by the cognizant engineering organization. When any of these parameters are not specified, they shall be established in accordance with 3.2.8 of this specification and listed as process control parameters in accordance with 3.7.

1.4 Processes, such as tumble peening, slurry peening, peen forming and straightening, peening for prevention of intergranular corrosion, and peening to produce a surface texture, are recognized but their requirements are not covered.

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 canceled 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.

AMS 2431	Peening Media
SAE J442	Test Strip, Holder and Gage for Shot Peening

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

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

2.3 ISO Publications

Available from American National Standards Institute, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.

ISO 10012-1 Quality Assurance Requirements for Measuring Equipment - Part 1: Metrological Confirmation System for Measuring Equipment

3. TECHNICAL REQUIREMENTS

3.1 General

3.1.1 Areas Designated to be Peened

Parts shall be peened on all surfaces, except peening is optional on inside surfaces of (1) holes and apertures under 0.125 inch (3.18 mm) diameter or width and (2) blind holes and recesses under 0.5 inch (13 mm) in diameter or width, if depth exceeds diameter or width. Use of ricochet peening shall be acceptable to the cognizant engineering organization.

3.1.1.1 Areas designated not to be peened shall be masked from the peening stream (See 8.3.1).

3.1.1.2 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 (See 3.2.8).

3.1.1.3 Peening coverage is optional in areas where peening is neither specified nor prohibited.

3.1.2 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), except for expendable masking, when approved by the cognizant engineering organization (See 8.2.4) that shall be plus 0, minus 0.125 inch (3.18 mm) (See 8.3.1).

3.1.3 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.

3.2 Material and Equipment

3.2.1 Peening media shall conform to AMS 2431.

3.2.2 Measuring Instruments

Almen gages, scales, air pressure gages, tachometers, and other applicable instruments, used for controlling shot peening, shall be calibrated against instruments whose calibration is traceable to National Institute of Standards and Technology (NIST) or other nationally accredited standards organization acceptable to the cognizant engineering organization.

3.2.3 Almen test strips used for intensity verification shall conform to SAE J442 except thickness and flatness tolerance shall be ± 0.0005 inch (± 0.013 mm). A method of compensating for initial out of flatness may be used if approved by the cognizant engineering organization. Mechanically deforming strips to meet the flatness requirement is not permitted. Hardness shall be 73.0 to 74.5 HRA for N strips and 45 to 48 HRC, or equivalent, for other strips. Hardness shall be measured in accordance with ASTM E 18 at approximately 1/2 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.

3.2.3.1 Gages for determining flatness and arc height of Almen test strips shall conform to the requirements of SAE J442, 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 block that is flat within 0.0002 inch (0.005 mm).

3.2.3.2 Masked Test Strips

In locations where standard test strips cannot be placed to accurately reflect the peening intensity, masked test strips may be used. 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 or subsize test strip shall be used for control of the peening intensity. Masked test strips shall conform to all requirements of 3.2.3 except for length and width of exposed area.

3.2.3.3 Reuse of Almen test strips is not permitted.

3.2.3.4 Almen Strip Fixture

Either a scrap part or a representative non-adjustable fixture shall be fitted with test strip support blocks (See 3.1.3). Support blocks used to hold Almen test strips, during tests to establish specified peening intensity, shall conform to SAE J442 and shall be secured to the Almen test strip fixture. If support blocks for masked test strips are used, they shall be approved by the cognizant engineering organization. The Almen strip fixture shall be oriented to the peening shot stream and rotated or translated in the same manner as the part. The design of the Almen strip fixture shall be approved by the cognizant engineering organization. It shall be numbered and recorded in the procedure sheet (See 3.7.2.1) and shall be used for all subsequent Almen intensity verifications.

3.2.4 Peening machines shall be equipped with computers for continuously monitoring and recording the parameters shown in Table 1 within the tolerance indicated. Recording can be in hard copy or alternative record system approved by the cognizant engineering organization.

TABLE 1 - PARAMETERS FOR PEENING MACHINES

Paragraph	Parameter	Units	Process Tolerances Shutdown Limits Plus or Minus
3.2.4.1	Shot Flow (for each nozzle)	Pounds/minute (kg/minute)	10%
3.2.4.2	Air Pressure (for each nozzle)	psi (kPa)	> 20 psi 10% ≤ 20 psi 20%
3.2.4.3	Wheel Speed (for each wheel)	rpm	> 2000 rpm 1% ≤ 2000 rpm 20 rpm
3.2.4.4	Nozzle or Wheel Translation Speed	Inch/minute (mm/minute)	10%
3.2.4.5	Deflector Speed	Inch/minute (mm/minute)	10%
3.2.4.6	Nozzle and/or Wheel Shut Down	Seconds	1
3.2.4.7	Turntable Speed	rpm	10%
3.2.4.8	Part Speed	rpm/inch/minute (mm/minute)	10%

TABLE 1 - PARAMETERS FOR PEENING MACHINES (CON'T.)

Paragraph	Parameter	Units	Process Tolerances Shutdown Limits Plus or Minus
3.2.4.9	Conveyor Speed	Inch/Minute (mm/minute)	10%
3.2.4.10	Peening Cycle Time	Seconds	1
3.2.4.11	Nozzle/Wheel Position	Inch/degree (mm/degree)	0.062 inch (1.57 mm)/ 5 degrees
3.2.4.12	Table/Part Indexing	Inch/degree (mm/degree)	0.062 inch (1.57 mm)/ 5 degrees

Calibration of measuring devices used in the peening system shall be performed in accordance with ISO-10012-1.

3.2.5 Air Pressure Measurement

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.

3.2.6 Process Intensity Verification

Arc height measured during production verification shall not vary from that of the initial procedure qualification at any specimen location by more than ±0.0015 inch (±0.038 mm) Almen A. At no time shall these measurements fall below the minimum specified on the engineering drawing.

3.2.7 The peening system shall be capable of interrupting the peening cycle within one second, when excursions outside set tolerances are detected for shot flow (3.2.4.1), air pressure (3.2.4.2), wheel speed (3.2.4.3), nozzle and/or wheel translation speed (3.2.4.4), turntable speed (3.2.4.7), part speed (3.2.4.8), or conveyor speed (3.2.4.9). The peening system shall also retain in memory and print out any abort details for the parameters listed in Table 1 and be able to resume operations to complete the balance of the process cycle, from the position of shut-down, when the out-of-tolerance condition has been corrected. Parts processed during an aborted cycle shall be so identified on the peening certificate and/or computer print-out.

3.2.8 If media size and intensity are not specified, media size and intensity shall conform to the requirements of Table 4 and Table 5. It is recommended that Table 4 and Table 5 be used as media size and intensity guidelines by the design engineer. See 8.5 for a description of media types.

3.2.9 Peening machine shall be equipped with 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 Table 6.

3.2.10 Labeling of Gages

ISO 10012-1 shall be used for labeling of gages.

3.3 Prepeening Treatment

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

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

3.3.3 Heat treatment that requires temperatures above those in 8.3.3 shall be completed prior to peening.

3.3.4 All machining of areas to be peened shall be completed prior to peening unless additional peening operations are to be carried out on subsequently machined areas (See 8.3.1). All burrs shall be removed and all sharp edges and external corners shall be radiused or chamfered.

3.3.5 Nondestructive inspection, such as magnetic particle, fluorescent penetrant, ultrasonic, or other flaw or crack detection processes, when required, shall be completed prior to peening.

3.3.6 Parts that exhibit corrosion or mechanical damage shall not be peened unless the noted condition is acceptable to the cognizant engineering organization.

3.3.7 Cleaning, prior to peening, shall be accomplished by methods acceptable to the cognizant engineering organization that ensure removal of contaminants such as oil or grease.

3.3.7.1 Titanium alloys shall not be cleaned in solvents containing halogenated compounds.

3.4 Procedure Development

3.4.1 Fillet radii requiring peening shall be peened with shot size whose nominal diameter does not exceed one half the fillet radii of the subject radii. If this requires a shot size that is smaller than that shown in Table 4 and Table 5, the fillet radius shall be peened in a separate setup subsequent to the one required for general peening of the part. An intensity for the fillet radius, compatible with the smaller shot size, shall be established by the cognizant engineering organization. No additional masking of previously peened areas is required. For slots or other apertures, through which shot must pass to peen other areas, the nominal shot diameter shall not be greater than one-quarter the diameter or width of such aperture.

3.4.2 Holes larger than 0.125 inch (3.18 mm) diameter (See 3.1.1) shall be peened to the requirements of Table 4 and Table 5, utilizing internal peening setups if required by drawing. No internal setups are required if the hole diameter is equal to or larger than half the hole depth, provided that the hole is open to direct impingement from both ends. If the hole diameter is equal to or larger than the hole depth and the hole is accessible to direct impingement from one end only, external peening with the shot size and intensity specified for the actual part is acceptable, provided that the hole receives complete coverage.

3.4.3 For internal peening, the part shall be positioned so as to ensure free exit of spent shot.

3.4.4 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 4 and Table 5), the part shall be peened as follows, or as otherwise directed by the cognizant engineering organization.

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

3.4.4.2 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.

3.4.4.3 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. Complete 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.

3.4.5 Loads

No external loads shall be applied to the part during peening unless specified by the cognizant engineering organization.

3.5 Preproduction Setup Verification

3.5.1 Saturation Curve

Intensity shall be determined by exposing individual Almen strips in a setup fixture (See 3.2.3) for increasing time periods and plotting the results as a saturation curve, represented in Figure 1 (See 8.2.1). No fewer than four points, other than zero, shall be required to adequately define the saturation curve.

3.5.1.1 During procedure development for a new part in a given machine, a complete saturation curve shall be developed for each intensity verification location and the curves shall form part of the peening procedure sheet. The peening parameters, confirmed by the saturation curves and intensity verifications, shall be entered into the computer control program for each part (See 3.7.2).

3.5.1.2 Shutdown limits for air pressure and shot flow shall be refined during procedure development to protect drawing intensity requirements. To establish shutdown limits, two arc height tests shall be conducted at the saturation 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 procedure sheet.

3.5.2 Coverage

Unless otherwise designated on the part engineering drawing, 100% part coverage is required (See 8.2.2).

3.5.3 Production peening setups shall utilize the computer 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, at exposure time “T”, after all monitored parameters, fixtures, and locations match the computer program and the procedure sheet. If any strips do not fall within required intensity range, the setup shall be corrected and effected parameters re-entered in accordance with 3.5.1.1.

3.5.4 Nozzle HoldIng Fixture

When 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 procedure sheet during peening. The nozzle holding fixture, when used, shall be numbered and recorded on the procedure sheet.

3.5.5 Control Cage Setting

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.

3.5.6 Part Holding Fixture

If part is held in a fixture, the fixture shall be designed to rotate and/or translate the part on its axis through the shot stream. The fixture shall be numbered and recorded on the peening procedure sheet (See 3.7.2 and 3.7.2.1).

3.6 Post-Peening Treatment

3.6.1 After peening and removal of protective masking, all shot and shot fragments shall be removed from surfaces of parts. Only methods that will not erode or scratch surfaces shall be used.

3.6.2 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 shall not be used unless approved by the cognizant engineering organization (See 8.2.3).

3.6.2.1 For parts with a specified minimum tensile strength of 220 ksi (1517 MPa) and over, no more than the equivalent of 5% of the specified minimum "A" intensity (Table 3) or equivalent "N" or "C" intensity (See 8.6) shall be removed from the surfaces.

3.6.2.2 For other parts, no more than the equivalent of 10% of the specified minimum "A" intensity (Table 3) or equivalent "N" or "C" intensity (See 8.3.4.2) shall be removed from the surfaces.

3.6.3 Removal of Surface Contaminants

3.6.3.1 If required by purchaser, parts, other than those made from alloy or carbon steel that have been peened with carbon steel shot or with any media in an unlined steel cabinet, shall be decontaminated as follows:

3.6.3.1.1 Corrosion resistant steel and titanium alloy parts shall be decontaminated in accordance with Table 2 followed by an agitated water rinse at the stated temperature, and dried. Alternatively, glass beads may be used for decontamination when approved by the cognizant engineering organization.

TABLE 2 - DECONTAMINATION SOLUTION

Material Type	Solution	Solution Temperature	Time in Solution	Rinse Temperature
Corrosion-Resistant Steels and Titanium Alloys	20-50% by volume nitric acid and water	140 °F ± 10 60 °C ± 6	15-30 minutes	140 °F ± 10 60 °C ± 6

3.6.3.1.2 Aluminum alloy parts that have been peened with steel shot shall be cleaned by suitable methods to remove all iron contaminants. See 8.8.

3.7 Process Control

3.7.1 The setup shall be qualified by placing the Almen test strip setup fixture in the machine in the identical orientation to the shot stream to which the part shall be exposed. Air pressures, shot flow, or wheel speeds shall be adjusted to yield designated intensities and coverage. Nozzle positions or wheel cages shall be set so that shot streams have an angle of impingement between 90 and 45 degrees to the Almen strip locations, unless other angles are required and/or allowed by the cognizant engineering organization.

3.7.2 Peening Procedure Sheet

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.

3.7.2.1 Procedure sheets shall include a sketch of the machine setup showing nozzle placement and/or relation of wheel(s) to the part and the following information as applicable:

Procedure sheet number and approval date
Part number
Machine identification number (model and serial number)
Number of nozzles or wheels
Nozzle type: gravity, pressure, or suction
Fixture identification numbers (Almen strip fixture, part fixture, nozzle fixture, masking fixture)
Size of nozzles or wheels
Media size
Media Type
Media flow rate for each nozzle or wheel
Nozzle air orifice diameter
Nozzle or wheel translation speed, direction, and travel relative to part
Control cage position for each wheel and pattern relationship to part
Nozzle or wheel angles of impingement
Nozzle or wheel-to-part distance
Air pressure for each nozzle in gravity system
Air pressure at each nozzle for direct pressure and suction systems
Wheel speed in RPM for each wheel
Size and material of shot in accordance with AMS 2431
Speed, direction, and travel of part in translation and rotation
Areas to be masked including permissible areas for expendable maskant
Placement of test strips on intensity verification fixture in relation to the actual part
Saturation curve for each intensity verification point (3.5.1.1)

Peening exposure time
Sequence of nozzle or wheel shut down (if required)
Intensity
Coverage
Prepeening cleaning method (See 3.3.7)
Postpeening cleaning method (See 3.6.3)
Corrosion protection method (See 5.1).

3.8 Peening Source Qualification

Facilities performing computer controlled shot peening in accordance with this specification shall be approved by the cognizant quality assurance organization.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection and Process Control

The processor shall be responsible for the performance of all inspection specified herein except pretreatment specified in 3.3. The cognizant engineering organization reserves the right to perform any testing deemed necessary to ensure that processing conformed to specified requirements.

4.2 Classification of Tests

All technical requirements are acceptance tests and shall be performed on each lot in accordance with 4.3.1, 4.3.2, and 4.3.3; a lot shall consist of parts of the same part number that are processed continuously using the same machine setup.

4.3 Sampling for testing shall be as follows:

4.3.1 Shot Size and Uniformity

One or more verifications of shot size and uniformity shall be made on samples taken from a nozzle or wheel. The samples shall be taken for each production run, and every eight hours of production on long runs, when using cast or cut wire steel shot. Ceramic shot shall be similarly verified at least every four hours of production and before and after each production run. Glass bead shot shall be similarly verified at least every two hours of production and before and after each production run. Media samples shall meet requirements of Table 7 except broken shot count shall conform to the requirements of Table 6.

4.3.2 Intensity Verification

Strips shall be tested for conformance to hardness, thickness, and flatness requirements of 3.2.3.

4.3.2.1 One or more intensity determinations for all required locations shall be made immediately before and, for lot sizes greater than one, after each production run and at least every four hours of production.

4.3.3 Coverage Verification

Peened surfaces shall be examined for complete (100%) coverage on the first and last piece of a lot and on one piece at least after every four hours of continuous operation. Either of the following methods shall be used except as noted in 4.3.3.3.

4.3.3.1 Peened surfaces shall be inspected visually using 10X or higher magnification to determine that the surface has been completely covered with overlapping dimples.

4.3.3.2 Impact Sensitive Fluorescent Coatings

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

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

4.3.3.4 All coverage inspection shall be performed prior to any material removal.

4.4 Preproduction Approval

The process and 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.

4.5 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 specified requirements.

4.6 Reports

Results of Almen test strip measurements by location and the actual Almen test strips used to verify intensity shall accompany each lot of parts. The Almen test strips shall be permanently marked with their location on the Almen test fixture by a method that will not change intensity measurements.

5. PREPARATION FOR DELIVERY

5.1 Peened parts shall be handled and packaged to ensure protection from corrosion and damage during handling, transportation, and storage.

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

8.2 Terms used in this AMS are clarified in ARP 1917 and as follows:

8.2.1 Peening intensity (saturation point) is the minimum duration of peening which, when doubled, increases the Almen strip height by not greater than 10 percent. Arc height at saturation should correspond to arc height required for the part (See Figure 1). It is determined from a saturation curve.

8.2.2 100% coverage is defined as complete obliteration of the original surface finish by overlapping dimples.

8.2.3 Peening exposure time is determined by the time required to obtain 100% coverage of the part, unless the cognizant engineering organization directs it to be the time required to reach saturation.

8.2.4 Cognizant Engineering Organization is the term applied to the engineering organization responsible for the design of the parts or a designee of that organization.

8.3 Design Recommendations

8.3.1 In lieu of masking, designs may permit excess material to be left on surfaces where peening is prohibited so that it may be removed by subsequent machining; however, the residual stress distribution in the boundary zone will be altered.

8.3.2 The shot peening parameters shown in Table 4 and Table 5 may not be ideal for a specific part. It is, therefore, recommended that tests be conducted to optimize the shot peening parameters. The testing should include various shot sizes, types, and peening intensities. The optimum parameters should then be required by the drawing.

8.3.3 To preclude reduction of compressive stresses, temperature to which peened parts are subjected in subsequent processing should not exceed the following:

Alloy Steels	475 °F	(246 °C)
Corrosion-Resistant Steels	750 °F	(399 °C)
Aluminum Alloys	200 °F	(93 °C)
Titanium Alloys	600 °F	(316 °C)
Magnesium Alloys	200 °F	(93 °C)
Nickel and Cobalt Alloys	1000 °F	(538 °C)

8.3.3.1 Other maximum temperatures may be applicable for other reasons such as reduction of strength or corrosion resistance.

8.3.4 When requiring shot peening of sections under 0.090 inch (2.29 mm), design should utilize peening parameters that preclude high core tensile stresses.

8.3.4.1 The peening intensity used for thin sections should be such that the cross-sectional area under compressive stress should not exceed 10% of the total cross-sectional area.

8.3.4.2 Table 3 illustrates typical depths of compressive stress for shot peened components.

TABLE 3 - DEPTH OF COMPRESSIVE STRESS

Almen Intensity Material	0.008 N Inch	0.20 N mm	0.008 A Inch	0.20 A mm	0.008 C Inch	0.20 C mm
Aluminum	0.003	0.08	0.010	0.25	0.027	0.69
Titanium	0.002	0.05	0.007	0.18	0.018	0.46
Steel under 200 ksi (1379 MPa) tensile strength	0.003	0.08	0.008	0.20	0.025	0.64
Steel 200 ksi (1379 MPa) tensile strength and over	0.002	0.05	0.005	0.13	0.015	0.38
Nickel alloys	0.002	0.05	0.006	0.15	0.020	0.51

8.4 Parts that are significantly softer (e.g. aluminum) than the Almen strips will become fully covered in much less time than that required for the test strips to attain saturation. Conversely, much harder parts will require increased exposure.

8.5 The following is a brief description of the media types specified by AMS 2431.

2431/1 ASR Cast Steel Shot, Regular
Most commonly used medium.

2431/2 ASH Cast Steel Shot, Hard
Used when part hardness exceeds 50 HRC and it is necessary to produce a higher magnitude compressive stress than possible with regular cast steel shot. In such applications, it will break down faster than regular cast steel shot.

2431/3 AWC Conditioned Carbon Steel Cut Wire Shot
Superior breakdown resistance to either type of cast steel shot. It has a higher cost than cast steel shot.

2431/4 AWS Conditioned Stainless Steel Cut Wire Shot
Superior breakdown resistance to cast steel shot and is selected when passivation and/or chemical decontamination of nonferrous shot peened parts is not desired. It has a higher cost than cast steel and carbon steel cut wire shot.

2431/5 APB Peening Balls
Superior breakdown resistance to cast steel shot. Superior sphericity over all types of medium. It has a higher cost than cast steel, conditioned carbon steel cut wire, and conditioned stainless cut wire shot.

2431/6 AGB Glass Shot
When new, glass shot provides less degradation of smooth surfaces, reduces roughness of rougher surfaces, eliminates necessity for post-peening passivation or other chemical decontamination of parts made from stainless steel or nonferrous materials. Glass shot exhibits a higher breakdown rate than all other types and, therefore, is not recommended for high peening intensities.

2431/7 AZB Ceramic
Used as an alternative to glass shot as its breakdown resistance is superior to glass shot for similar sizes and intensities. It has a higher cost than glass shot.

8.6 Intensity Comparisons

For comparisons of the nominal intensity designations, Type C Almen test specimen deflection may be multiplied by 3.5 to obtain the approximate deflection of a Type A Almen test specimen when shot peened with the same intensity. Almen test strip "A" is ordinarily used for arc heights up to 0.024 inch (0.61 mm); for greater degrees of peening, Almen test strip C is used. For intensities below 0.004A, the Almen test strip Type "N" should be used. For comparison of the nominal intensity designations, Almen test strip Type "A" test specimen deflection may be multiplied by three to obtain the approximate deflection of any Almen test strip Type "N" specimen when shot peened at the same intensity.

8.7 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.

8.8 Exposure of aluminum alloy parts to a fresh aqueous solution of nitric acid can remove surface iron contamination. For example, exposure to 50% ± 5 by volume nitric acid operated at ambient temperature or 20% ± 2 by volume nitric acid operated at 140 °F ± 5 (60 °C ± 3) for 10 minutes or more has been found to be effective followed by a rinse with hot (140 °F (60 °C)), agitated water and drying.

8.9 Purchase documents should specify not less than the following:

AMS 2432C
Part number of parts to be peened
Quantity of parts to be peened

8.10 Similar Specifications

MIL-S-13165 is listed for information only and shall not be construed as an acceptable alternative unless all requirements of this AMS are met.

TABLE 4 - SHOT SIZES AND INTENSITIES FOR STEEL AND TITANIUM PARTS EXCEPT AS SPECIFIED IN 3.4

	Material Thickness 0.090 to 0.375 Inch (2.29 to 9.52 mm), Inclusive		Material Thickness Over 0.375 Inch (9.52 mm)	
Material [1]	Shot Size	Intensity	Shot Size	Intensity
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, minimum tensile strength 200 ksi (1379 MPa),and under	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, minimum tensile strength over 200 to 260 ksi (1379 to 1793 MPa), incl	170, 230	0.008 to 0.012A (0.20 to 0.30A)	230, 330	0.012 to 0.016A (0.30 to 0.41A)
All Alloys Holes Under 0.750 inch (19.05 mm) diameter	70, 110	0.010 to 0.015N (0.25 to 0.36N)		

Notes:

1. Any shot size and intensity specified on the engineering drawing shall take precedence.
2. Sizes in Table 4 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 engineering drawing.
3. For material thickness under 0.090 inch (2.29 mm) (See 3.1.1.2). Any shot size

TABLE 5 - SHOT SIZES AND INTENSITIES FOR ALUMINUM PARTS, EXCEPT AS SPECIFIED IN 3.4

Areas to be Peened	Intensity (1)	Shot Size (1)
Sections over 0.375 inch (9.52 mm)	0.010 to 0.014A (0.25 to 0.36A)	230, 330
Sections 0.090 to 0.375 inch (2.29 to 9.52 mm), incl, in thickness	0.006 to 0.010A (0.15 to 0.25A)	170, 230
Holes under 0.735 inch (18.67 mm) in diameter	0.010 to 0.015N (0.25 to 0.38N)	70, 130

Notes:

1. Any shot size and intensity specified on the engineering drawing shall take precedence.
2. Sizes in Table 5 are to 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 engineering drawing.
3. For material thickness under 0.090 inch (2.29 mm). See 3.1.1.2.

TABLE 6 - MAXIMUM NUMBER ALLOWABLE BROKEN PARTICLES

Shot Designation	Maximum Number Broken Particles	Test Area Inch	Test Area Millimeters
ASR/ASH			
660	5	1 x 1	25 x 25
550	7	1 x 1	25 x 25
460	9	1 x 1	25 x 25
330	5	½ x ½	13 x 13
230	9	½ x ½	13 x 13
170	17	½ x ½	13 x 13
110	10	¼ x ¼	6.4 x 6.4
70	26	¼ x ¼	6.4 x 6.4
AWC/AWS			
62	5	1 x 1	25 x 25
54	7	1 x 1	25 x 25
47	9	1 x 1	25 x 25
41	12	1 x 1	25 x 25
35	16	1 x 1	25 x 25
32	5	½ x ½	13 x 13
28	6	½ x ½	13 x 13
23	9	½ x ½	13 x 13
20	13	½ x ½	13 x 13
17	17	½ x ½	13 x 13
14	8	¼ x ¼	6.4 x 6.4
12	10	¼ x ¼	6.4 x 6.4

TABLE 7 - SIZE UNIFORMITY REQUIREMENTS OF SHOT IN MACHINE

Media Designation	All Pass U.S. Screen No., Inch (mm)		Max. 10% Passing U.S. Screen No., Inch (mm)	
Cast Steel				
930	5, 0.1570	(4.000)	8, 0.0937	(2.360)
780	6, 0.1320	(3.350)	10, 0.0787	(2.000)
660	7, 0.1100	(2.800)	12, 0.0661	(1.700)
550	8, 0.0937	(2.360)	14, 0.0555	(1.400)
460	10, 0.0787	(2.000)	16, 0.0469	(1.180)
390	12, 0.0661	(1.700)	18, 0.0394	(1.000)
330	14, 0.0555	(1.400)	20, 0.0331	(0.850)
280	16, 0.0469	(1.180)	25, 0.0278	(0.710)
230	18, 0.0394	(1.000)	30, 0.0234	(0.600)
190	20, 0.0331	(0.850)	35, 0.0197	(0.500)
170	25, 0.0278	(0.710)	40, 0.0165	(0.425)
130	30, 0.0234	(0.600)	45, 0.0139	(0.355)
110	35, 0.0197	(0.500)	50, 0.0117	(0.300)
70	40, 0.0165	(0.425)	80, 0.0070	(0.180)
Cut Wire				
62	8, 0.0937	(2.360)	14, 0.0555	(1.40)
54	10, 0.0787	(2.000)	16, 0.0469	(1.18)
47	12, 0.0661	(1.700)	18, 0.0394	(1.00)
41	14, 0.0555	(1.400)	20, 0.0331	(0.850)
35	16, 0.0469	(1.180)	25, 0.0278	(0.710)
32	16, 0.0469	(1.180)	25, 0.0278	(0.710)
28	18, 0.0394	(1.000)	30, 0.0234	(0.600)
23	20, 0.0331	(0.850)	35, 0.0197	(0.500)
20	25, 0.0278	(0.710)	40, 0.0165	(0.425)
14	35, 0.0197	(0.500)	50, 0.0117	(0.300)
12	40, 0.0165	(0.425)	60, 0.0098	(0.250)