



AEROSPACE MATERIAL SPECIFICATION

AMS2588™

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Ultrasonically Activated Needle Peen Forming

RATIONALE

This new specification establishes equipment and process requirements for forming or straightening metal parts using Ultrasonically Activated Needle Peening.

AMS2588 has been reaffirmed to comply with the SAE Five-Year Review policy.

1. SCOPE

1.1 Purpose

This specification covers the equipment and process requirements for forming or straightening metal parts using Ultrasonically Activated Needle Peening.

1.1.1 Process Description

Ultrasonic kinetic energy is transferred from a vibrating metallic element to the peen forming media (needles) contained in an end piece. See Figures 4 and 3 respectively. The equipment can be used manually by an operator or automatically in connection with a CNC machine, e.g., an industrial robot. The equipment set (Figure 1) is composed of a central control unit and a machine held tool, the peening head (Figure 2).

1.2 Applications

Ultrasonically activated needle peening is typically used to form and straighten metallic parts by inducing compressive residual stresses on selected surfaces in order to produce the desired part curvature. The process is successfully applied to part geometries for which the depth of introduced residual stresses is significant in comparison to part thickness at that location.

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 reference document has been cancelled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 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 of Metallic Materials

ASTM A 751 Standard Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products

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Documents

Document Sharing Hub

2.2 AISI Publications

Available from American Iron and Steel Institute , 1140 Connecticut Avenue, NW, Suite 705, Washington, DC 20036, Tel: 202-452-7100, www.steel.org.

ANSI/ASME B46.1 Surface Texture, Surface Roughness, Waviness and Lay

2.3 Definitions

2.3.1 Peening exposure time is determined by the time required to obtain the required curvature of the part.

2.3.2 Over-formed parts areas are more difficult to correct than unpeened or under-peened areas.

2.3.2.1 As each part may react differently, over-forming may occur and may be corrected by peening the opposite surface unless prohibited by drawing callout.

2.3.3 COVERAGE

The required curvature may not result merely from a fully covered surface. The part is processed to obtain a curvature and not a defined coverage. Coverage greater than 100% may not produce a significant increase of curvature.

2.3.4 COGNIZANT

The term applied to the engineering organization responsible for the design of the parts, its allied quality assurance organization, or a designee of these organizations.

2.3.5 END PIECE

Fixture encapsulating and guiding the needles. The end piece suitably locates and orientates needles on the sonotrode vibrating surface.

2.3.6 MEDIA BATCH

The particular material, hardness, size and amount of media (needles) that are used for a single setup.

2.3.7 MEDIA BATCH CHANGE POINT

The media (needles) batch renewal criteria when any of the related characteristics are out of requirements.

2.3.8 MEDIA CLUSTER

All the needles included on the End piece

2.3.9 SONOTRODE VIBRATION AMPLITUDE

Vibration amplitude is the axial displacement of the sonotrode top surface that throws the media. The amplitude is characterized by the difference between the peak and valley of the sine wave displacement.

2.3.10 SOURCE

The organization from which the manufactured needles are purchased and which provides the statement of conformity (4.3.6).

2.3.11 CNC MACHINE

A machine tool that uses programs to precisely and automatically displace the peening head above the peened part locations (e.g. robot, multiple axis CNC milling machine).

3. TECHNICAL REQUIREMENTS

3.1 Equipment

3.1.1 Central Control Unit and Peening Head:

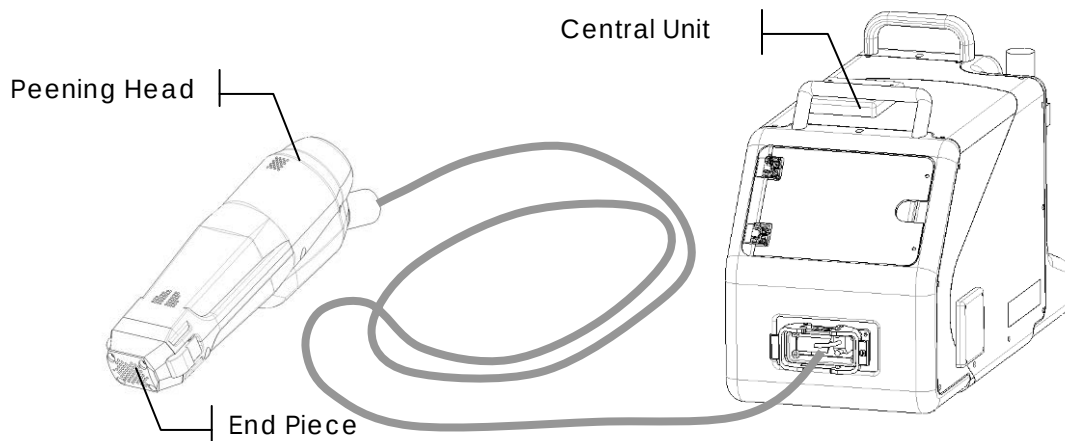


FIGURE 1: EQUIPMENT SET DESCRIPTION

The ultrasonically activated needle peening equipment shall provide a means of transferring kinetic energy to the needle contained in an end piece using a metallic element vibrating at an ultrasonic frequency. The equipment set (Figure 1) shall consist of a central unit and a hand held tool, the peening head.

3.1.1.1 Peening Head

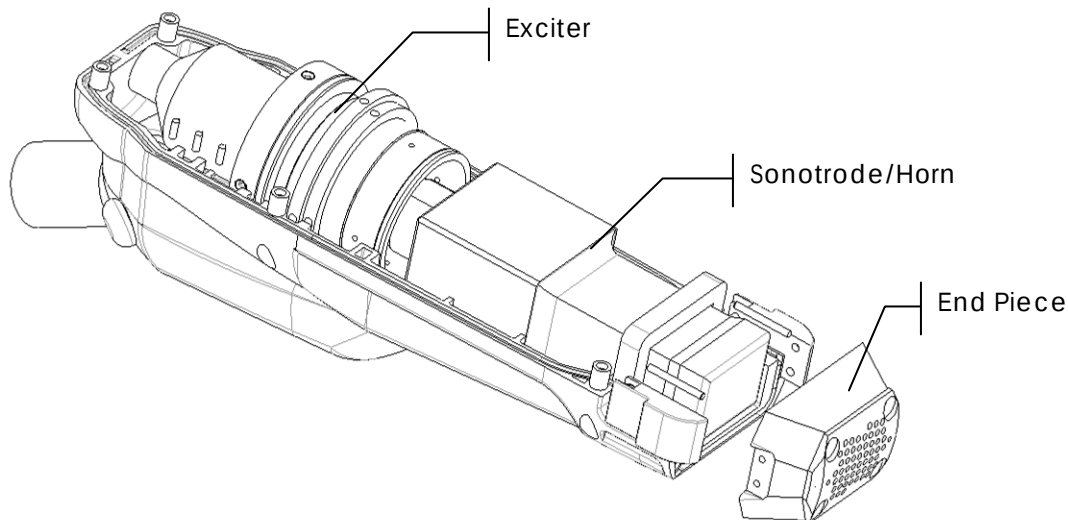


FIGURE 2: PEENING HEAD COMPONENTS

The peening head (Figure 2) shall consist of a piezo-electric exciter and a sonotrode (Horn) and, in some cases, a booster used to amplify the vibration.

3.1.1.2 Sonotrode (Horn)

The sonotrode is the metallic element vibrating at an ultrasonic frequency that transfers kinetic energy to the needles.

3.1.2 End piece:

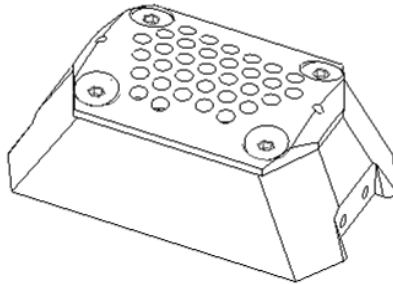


FIGURE 3: END-PIECE EXAMPLE

The end piece (Figure 3) is the component that contains and guides the needles (Figure 4). End pieces can be part-specific and location-specific as required to achieve the requirements, although each end piece may be used for other parts depending upon geometry. See 4.6.3.

3.1.2.1 Each end piece shall be referenced and serialized. The end piece(s) selected shall be suitable for the area(s) of the part being peened. The end piece material shall be chosen to limit the part abrasion and the localized heat that occurs during the needle peening process.

3.1.3 Needle Technical Requirements

3.1.3.1 For metal parts, the needles shall conform to the requirements of Table 1 unless otherwise approved by the cognizant engineering organization. See 4.6.3.

3.1.3.2 Needles shall conform to the following requirements:

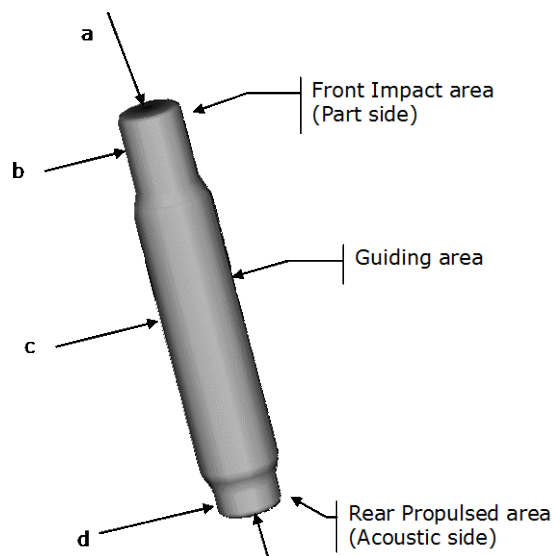


FIGURE 4: NEEDLE GEOMETRY

TABLE 1: DIMENSIONS AND HARDNESS OF STEEL NEEDLES

Reference	a	b	c	d	Hardness
2/1.2 R0.75	0.030(0.75)	0.047(1.2)	0.079(2)	0.047(1.2)	60-66 HRC
3/2 R5.35	0.211(5.35)	0.079(2)	0.118(3)	0.079(2)	60-66 HRC
4/3 R8	0.315(8)	0.118(3)	0.157(4)	0.118(3)	60-66 HRC
5/4 R16	0.630(16)	0.157(4)	0.197(5)	0.157(4)	60-66 HRC

Notes:

Dimension units are inch (mm)

'a' is front impact end radius

'b' is front impact end diameter

'c' is guiding diameter

'd' is rear thrown end diameter

3.1.3.3 The impact surface of the needles shall be free of scratches and cracks. They shall be inspected at 10 to 20X magnification daily and replaced if small impact cracks are found which can result in material removal and create potentially damaging sharp edges.

3.1.3.4 Protection

Needles shall be visibly free of grease and oil before being loaded into the end piece.

3.1.4 Peening Head Parameter Monitoring:

The equipment shall be equipped with computerized devices for continuously monitoring the part-number-specific parameters shown in Table 2 within the usual tolerances indicated.

TABLE 2: TOLERANCES FOR ULTRASONICALLY ACTIVATED NEEDLE PEENING HEAD

Parameter	Units	Process Tolerance Plus or Minus
Amplitude	Inches (millimeters)	0.00024 (0.006)
Frequency	Hz	400

The amplitude of sonotrode vibration shall be recorded at the beginning of the operation and each time it is set to another value.

The amplitude shall be recorded every 4 hours maximum of continuous use and each time the treatment is interrupted for more than one hour, unless another schedule is approved by the cognizant engineering organization

The amplitude shall be measured using a mechanical, electronic or optical gage accurate to 0.00004 inch (0.001 mm) displacement.

3.1.5 The equipment shall be capable of maintaining the amplitude within the Table 2 tolerances and capable of aborting peening within one second after a detected tolerance for frequency in Table 2 is exceeded. The peening equipment shall retain in memory any abort details for the parameters listed in Table 2 and be capable of resuming operation to complete the balance of the peening operation from the position of shut down after the out-of-tolerance condition has been corrected. Parts processed during an aborted cycle shall be reported by the processor.

3.1.6 For automatic operation, needle peening device displacements shall be also monitored. The peening shall be interrupted when Table 3 limits are exceeded.