STANDARD OVERHAUL PRACTICES MANUAL

SHOT PEENING

PART NUMBER NONE

PUBLISHED BY BOEING COMMERCIAL AIRPLANES GROUP, SEATTLE, WASHINGTON, USA
A DIVISION OF THE BOEING COMPANY
PAGE DATE: Jul 01/2009

STANDARD OVERHAUL PRACTICES MANUAL

Revision No. 36
Jul 01/2009

To: All holders of SHOT PEENING 20-10-03.

Attached is the current revision to this STANDARD OVERHAUL PRACTICES MANUAL

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STANDARD OVERHAUL PRACTICES MANUAL

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STANDARD OVERHAUL PRACTICES MANUAL

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INTRODUCTION

1. General

A. The instructions in this manual tell how to do standard shop procedures during maintenance functions from simple checks and replacement to complete shop-type repair.

B. This manual is divided into separate sections:

(1) Title Page

(2) Transmittal Letter

(3) Highlights

(4) Effective Pages

(5) Contents

(6) Revision Record

(7) Record of Temporary Revisions

(8) Introduction

(9) Procedures

C. Refer to SOPM 20-00-00 for a definition of standard industry practices, vendor names and addresses, and an explanation of the True Position Dimensioning symbols used.

D. The data is general. It is not about all situations or specific installations. Use it as a guide to help you write minimum standards.

E. If the component overhaul instructions are different from the data in this subject, use the component overhaul instructions.

SHOT PEENING

1. INTRODUCTION

A. The data in this subject comes from Boeing Process Specifications BAC5730, BAC5730-2 and BAC5951. The airline has a copy of the Boeing Process Specification Manual.

B. The data is general. It is not about all situations or specific installations. Use this data as a guide to help you write minimum standards.

C. Refer to SOPM 20-00-00 for a list of all the vendor names and addresses.

2. DESCRIPTION

A. Shot peening is a procedure to cold work metal parts to harden the surfaces and remove residual stresses. It puts compressive stresses in the peened surfaces to increase fatigue strength and resistance to stress corrosion cracking. It also can be used to increase oil retention properties, as on gear teeth. Metal shot is usually specified, but glass bead peening can be specified when a very shallow compressive layer is necessary or iron contamination of non-ferrous parts is important. Glass bead peening could also be specified to follow metal shot peening to make the surface finish smoother.

B. Definitions

(1) Shot size and shot number

(a) Shot size is the nominal diameter of the shot in inches.

(b) Shot number is the shot size in ten-thousandths inch diameter units (for cast steel and glass beads) and thousandths-inch diameter units (for cut wire). For example, a cast steel shot peen callout of 170-330 shot number refers to 0.017-0.033 inch shot size, while a shot peen callout of CW41-CW47 refers to cut wire of diameters 0.041-0.047 inch.

(c) Sometimes these two terms are used interchangeably.

(2) Intensity (Almen intensity) – A numerical value or range designating the arc height (inch) in the gage length of an Almen standard test strip of hardened steel, peened on one side while clamped in a block. Peening action cold-works the top surface to cause the strip to become a curve, into an arc shape. A letter suffix is added to the arc height to identify the type of Almen test strip. For example, a callout of 0.010-0.015 A2 intensity refers to shot peening sufficient to cause an Almen A test strip in a Type 2 gage to become an arc with a height 0.010-0.015 inch from its original flat condition. The 2 is often not included in the callout, because the Type 2 test gage is the industry standard.

NOTE: Almen test strips A, C, and N are available to measure a wide range of shot peening intensities, but nominal intensities are usually given in Almen A equivalents. Almen A strips are used for intensity ranges 0.005-0.024 inch. For peening intensities 0.025-0.032A, either Almen A or C strips can be used, with C strips preferred. Over 0.032A, only C strips are used. Almen N strips are used for intensities below 0.004A. Intensities of C and N strips are equivalent to Almen A as follows: Almen A equivalent = Almen C arc height times 3.5 or Almen N arc height divided by 3.0.

(3) Coverage measures the extent of peening indentations on the surface peened.

(a) Coverage is specified as an integer (1.0, 2.0) or a percentage (100%, 200%).

(b) Coverage of 1.0 or 100% makes the surface completely covered with dents when seen without magnification. When examined under magnification, individual unpeened islands are permitted, but they must be at random locations, and the width of any unpeened island must be less than the typical indentation diameter.

(c) Coverage greater than 1.0 or 100% is specified by multiples of the exposure time the surface must be in the blast for 100% coverage. For example, for a coverage of 2.0 or 200% the part must be exposed to the shot blast for a period of time two times that necessary for 1.0 or 100% coverage.

3. MATERIALS AND EQUIPMENT

NOTE: The items in Paragraph 3.A. thru Paragraph 3.D. are available from vendors such as Wheelabrator (V0CJ83 or V70490), Metal Improvement Company (V05314 or V4G527), Pangborn (V45586), or Vacu-Blast (V6V892 or V62555) or B&J Industrial Supplies (V8H926).

NOTE: MIL-S-13165 is replaced by AMS-S-13165. MIL-S-851 is replaced by AMS 2431.

A. Shot

(1) Cast steel shot per SAE J827, screened per SAE J444.

(2) Cast steel hard shot, Rockwell C hardness, 55-65, per SAE J827, screened per SAE J444.

(3) Corrosion resistant steel (CRES) and carbon steel conditioned cut wire (CW) shot per SAE J441.

(4) Glass beads per MIL-G-9954, screened per AMS 2431.

(5) Ceramic beads – Zirshot, V03TK2.

B. Almen test strips per Figure 1.

C. Holding fixtures

(1) Standard test strip holding fixture per Figure 2.

(2) Fixed-hole test strip holding fixtures per Figure 5.

(3) Adjustable Almen test strip holding fixture (per tool drawing ST9500K and Figure 5), for verification of Almen intensity for holes peened with probe equipment only.

(4) Almen test strip attachment in all fixtures per Figure 2, Figure 3.

D. Test gage (Almen Gage No. 2) per Figure 4.

E. Sieves per RR-S-366 or JIS-Z-8801

F. Shot classifiers

(1) Matson Shot Classifier, V05314 or V4G527

(2) Vibro-Energy Separator, model LS24C44, V87315

(3) Gilson Testing Screen, model TS-1, V22898

G. Peening Coverage Verification Coating – Peen Scan, V3H711

H. Shot Peening Machine

(1) The automatic shot peening machine must give controlled intensity results. It must shoot dry shot in a smooth flow against the part by controlled air pressure or controlled centrifugal force. The machine must automatically move the part through the shot stream or move the shot stream over the part in translation or rotation or both. The machine must let broken or defective shot and contaminants such as rust and dirt be removed during peening. Air used to shoot the shot must be filtered and dried such that the shot and the peened surfaces have no signs of oil or moisture. The machines must have controls for peening time and the rate of shot flow.

(2) Shot peen with automatically controlled equipment unless as shown below.

(a) Manually operated equipment and portable equipment can be used to shot peen in the field and for repair operations or when specified by the overhaul instructions.

(b) Portable equipment must supply shot at a controlled rate, collect the used shot, and put the shot in a location for recycling.

(c) Manually controlled peening or self contained shot peening can be used for the surface of holes, edges, cutouts, etc., which cannot be economically peened with automatically controlled equipment.

I. Self-Contained Shot-Peening Materials

NOTE: Items (1), (2)(a), and (3) are available from 3M Company (V76381). These and the other items are also available from B&J Industrial Supplies (V8H926).

(1) Flap-peening wheels, 1 x 2 and 9/16 x 1-1/4 (Figure 6)

(2) Mandrel and sleeve assemblies (Figure 6)

(a) No. 7210 and 7211

(b) ST9503

(3) Magnetic Almen strip holder

(4) Almen test strips per Paragraph 3.B..

(5) Almen test gage per Paragraph 3.D..

(6) Power tool to turn the peening wheel and to keep the wheel speed within +/- 5% during the peening operation. The wheel speed can be measured with a tachometer, strobe light or equivalent.

(7) Abrasive paper – 320 to 400 grit aluminum oxide or silicon carbide (source optional)

MATERIAL: SAE 1070 COLD ROLLED SPRING STEEL

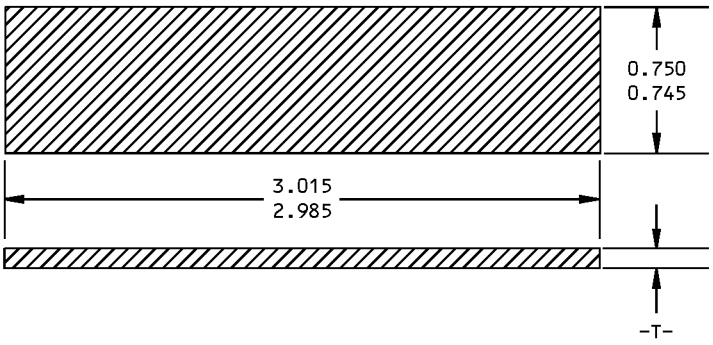
SQUARE EDGE NUMBER ONE ON 3 INCH EDGES

FINISH: BLUE TEMPER (OR BRIGHT) UNIFORMLY HARDENED AND TEMPERED TO RC 44-50

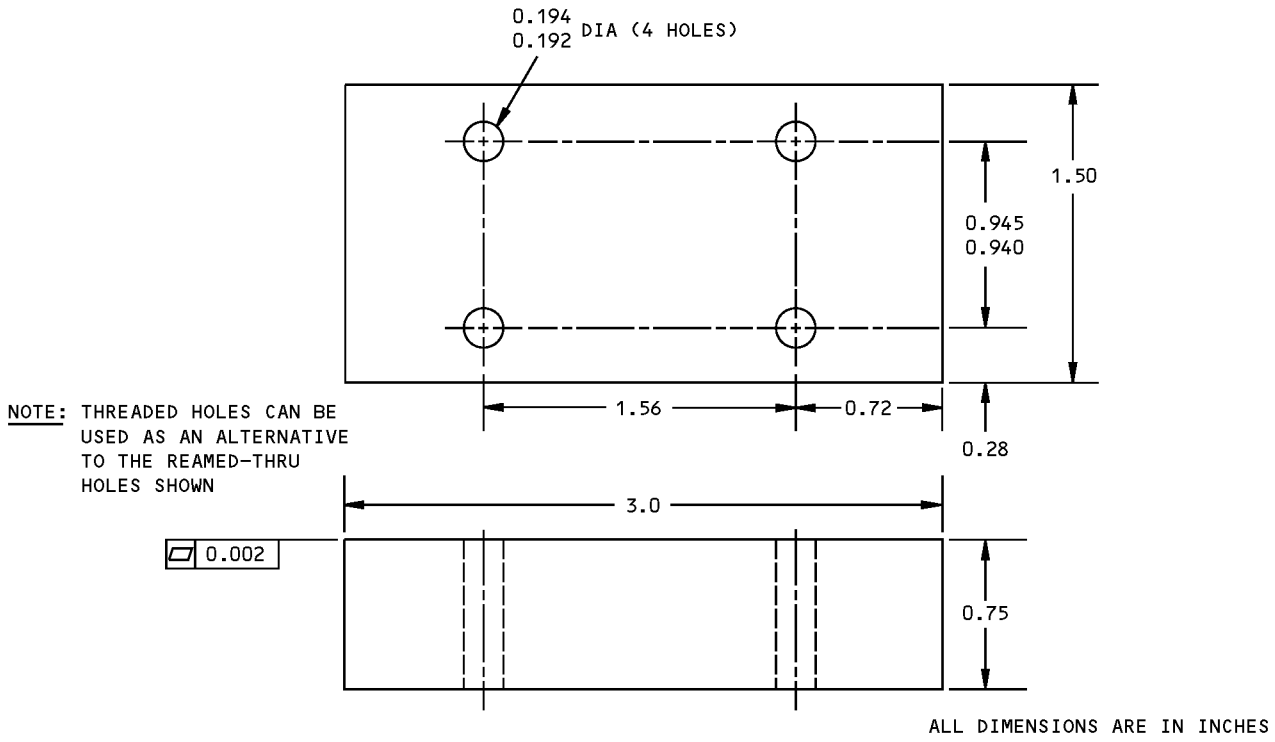
FLATNESS: ±0.0015 INCH ARC HEIGHT AS MEASURED ON TEST GAGE (SEE FIG. 4)

ALL DIMENSIONS ARE IN INCHES

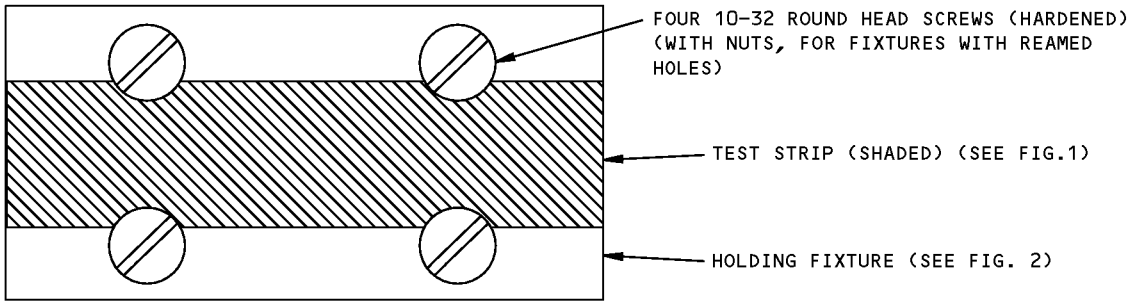
ALMEN TEST STRIP	A	C	N
THICKNESS -T-	0.052 0.050	0.095 0.093	0.032 0.030



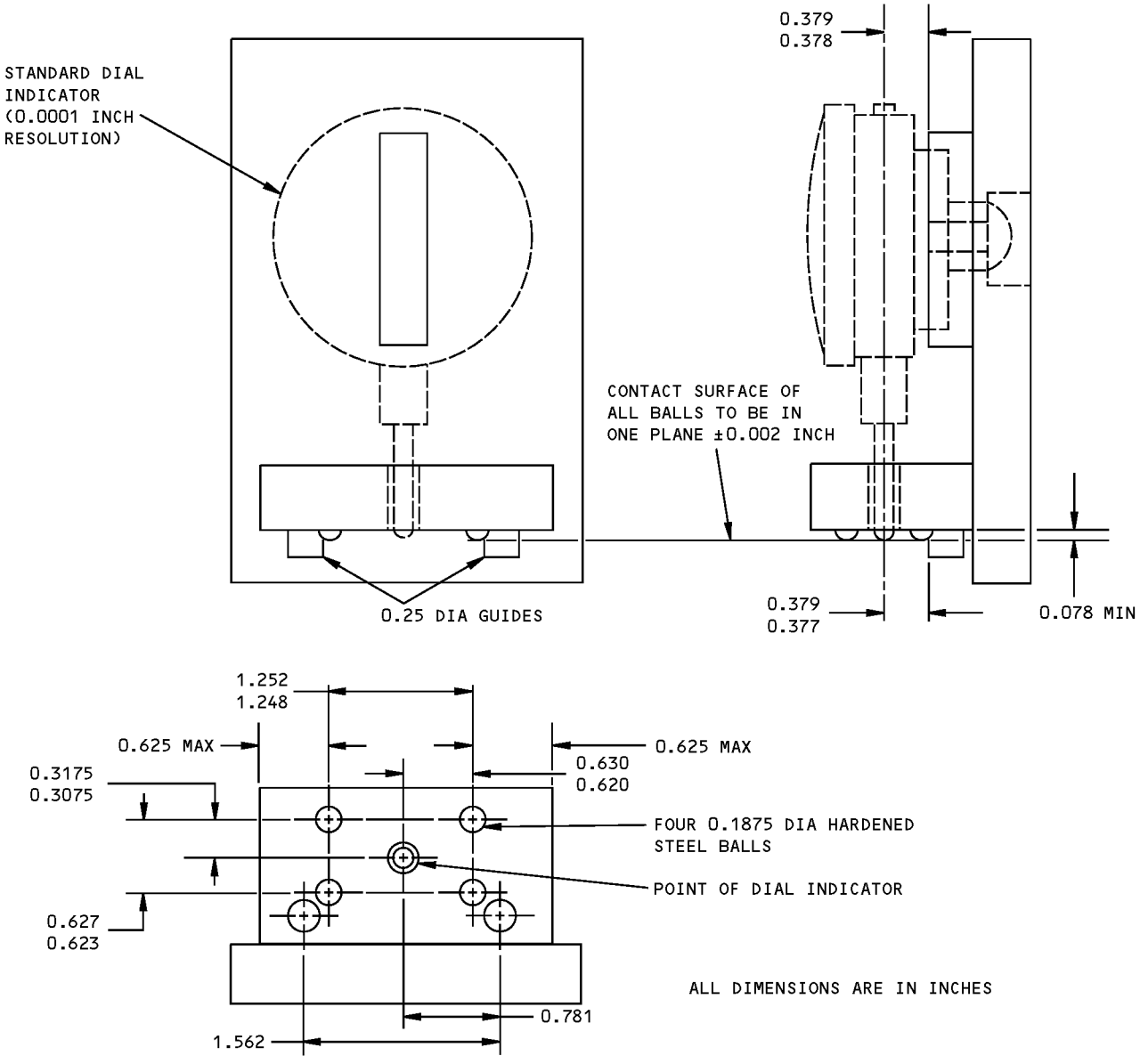
Almen Test Strip Details
Figure 1



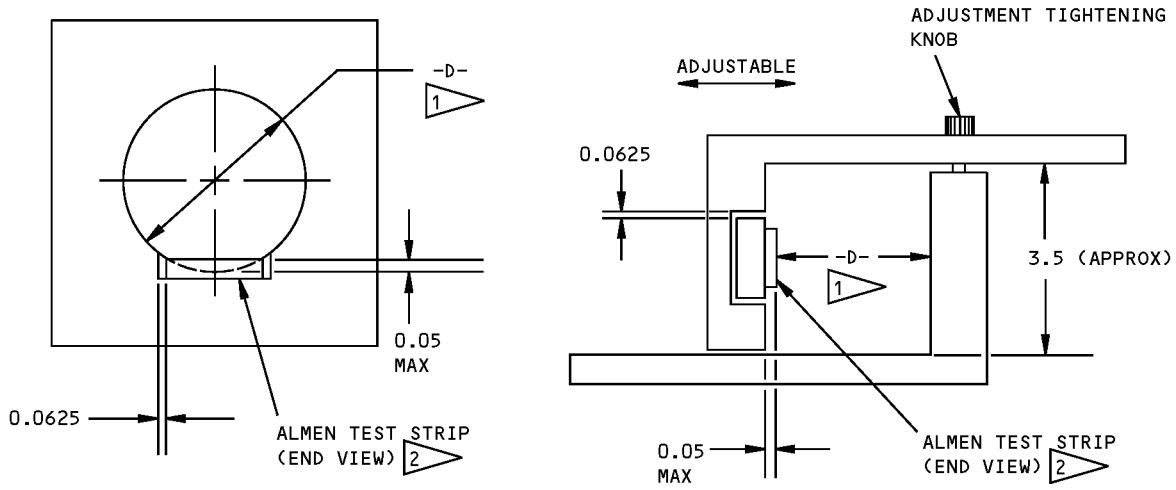
Holding Fixture Details
Figure 2



Assembled Test Strip and Holding Fixture
Figure 3



Almen No. 2 Test Gage Details
Figure 4



FIXED - HOLE FIXTURE

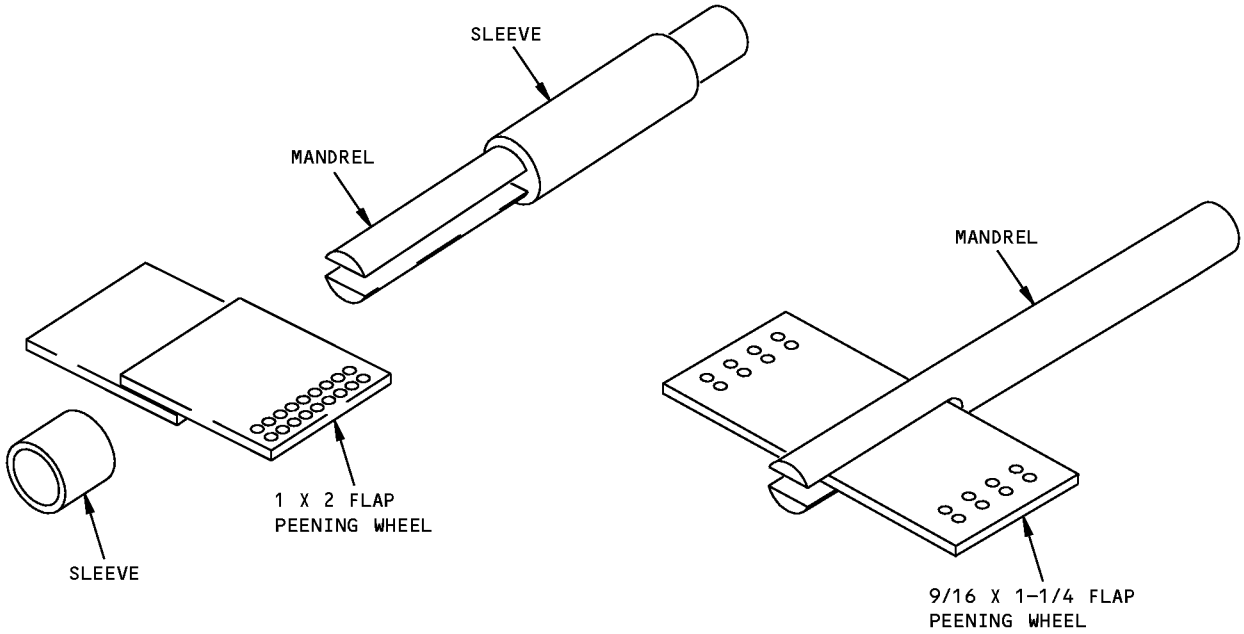
ADJUSTABLE FIXTURE (ST9500K)

1 -D- = PEENED HOLE DIAMETER ± 10% (MINIMUM SIZE, 0.9 ± 0.09 INCH)

2 TEST STRIP ATTACHMENT PATTERN AND LOCATION PER FIG. 2 AND 3

ALL DIMENSIONS ARE IN INCHES

Almen Test Strip Mounting Fixtures for Internal Diameters
Figure 5



D60262 S0000159802_V2

Peening Wheel Assembly
Figure 6

4. SURFACE PREPARATION

A. All machining but tooling tabs must be completed.

B. Surface finish in areas to be peened must be the design value or smoother unless overhaul instructions specify a pre-peening surface roughness.

C. Unless larger radii or chamfers are specified by overhaul instructions, give all sharp edges and corners a radius per Figure 7 to prevent edge rollover and bulges which are causes for peened part rejection.

D. If magnetic particle or penetrant inspection is specified, do it before shot peening. But, this does not prevent or replace such examination necessary as a final operation (such as magnetic particle examination after nickel or chrome plating).

E. Areas of parts to be shot peened must be free from surface coatings such as paint, oil, grease, plating, chemical treatments, or corrosion. If necessary, clean parts as follows:

(1) Low alloy steels heat-treated 220 ksi and above – Vapor degrease per BAC5408, or solvent clean per BAC5750 (SOPM 20-30-03).

(2) Low alloy steels heat-treated below 220 ksi – Vapor degrease per BAC5408, treat per BAC5625, alkaline clean per BAC5749, or solvent clean per BAC5750 or clean per BAC5751 (SOPM 20-30-03).

(3) Titanium and its alloys – Clean, descale and prepare per BAC5753 (SOPM 20-30-03).

(4) All other metals – Vapor degrease per BAC5408, alkaline clean per BAC5749, or solvent clean by hand per BAC5750 (SOPM 20-30-03).

Nominal Almen A Intensity	Material Thickness (Inch)	Radius (Inch)			
		Aluminum	Titanium	Steel	
				below 150 KSI	150-240 KSI	260-310 KSI
Up to 0.007	0.03	----------	----------	----------	----------	0.005 - 0.012
	0.04	----------	0.008 - 0.016	0.008 - 0.016	0.008 - 0.016	0.008 - 0.016
	0.05	0.015 - 0.025	0.010 - 0.020	0.010 - 0.020	0.010 - 0.020	0.010 - 0.020
	0.06	0.020 - 0.030	0.010 - 0.025	0.010 - 0.025	0.010 - 0.025	0.010 - 0.025
	0.07	0.025 - 0.035	0.010 - 0.030	0.010 - 0.030	0.010 - 0.030	0.010 - 0.030
	0.08 and greater	0.030 - 0.040	0.010 - 0.030	0.010 - 0.030	0.010 - 0.030	0.010 - 0.030
0.008 - 0.013	0.06	0.020 - 0.030	0.010 - 0.030	0.010 - 0.030	0.010 - 0.030	0.010 - 0.030
	0.08	0.030 - 0.040	0.010 - 0.035	0.010 - 0.035	0.010 - 0.035	0.010 - 0.035
	0.10	0.030 - 0.040	0.010 - 0.040	0.010 - 0.040	0.010 - 0.040	0.010 - 0.040
	0.13	0.040 - 0.060	0.010 - 0.040	0.010 - 0.040	0.010 - 0.040	0.010 - 0.040
	0.15	0.040 - 0.060	0.010 - 0.040	0.010 - 0.040	0.010 - 0.040	0.010 - 0.040
	0.17	0.050 - 0.070	0.010 - 0.040	0.010 - 0.040	0.010 - 0.040	0.010 - 0.040
	0.19 and greater	0.050 - 0.070	0.010 - 0.040	0.010 - 0.040	0.010 - 0.040	0.010 - 0.040
0.014 - 0.024	0.12	0.040 - 0.060	0.010 - 0.050	0.020 - 0.050	0.020 - 0.050	0.020 - 0.050
	0.15	0.040 - 0.060	0.020 - 0.060	0.020 - 0.060	0.020 - 0.060	0.020 - 0.060
	0.20	0.060 - 0.090	0.020 - 0.060	0.020 - 0.060	0.020 - 0.060	0.020 - 0.060
	0.23	0.060 - 0.090	0.020 - 0.060	0.020 - 0.060	0.020 - 0.060	0.020 - 0.060
	0.24 and greater	0.060 - 0.090	0.020 - 0.060	0.020 - 0.060	0.020 - 0.060	0.020 - 0.060
Over 0.024	0.18	----------	----------	----------	----------	0.020 - 0.060
	0.24	----------	----------	----------	0.020 - 0.060	0.020 - 0.060
	0.28 and greater	0.060 - 0.090	0.020 - 0.060	0.020 - 0.060	0.020 - 0.060	0.020 - 0.060

Corner and Edge Treatment
Figure 7

5. PEENING PROCEDURE

WARNING: EYE PROTECTION MUST BE USED AT ALL TIMES DURING SHOT PEENING OPERATIONS.

A. Shot Selection

(1) Use shot as follows:

(a) Use cast steel shot, or cast steel hard shot, unless the overhaul instructions are different.

(b) Use cast steel hard shot or conditioned cut wire, with Rockwell C hardness 55-65, for low alloy steels heat treated 200 ksi and above. This hard shot can also be used as an alternative for other metallic materials below Rc 46.

(c) As an alternative, CRES or carbon steel cut wire shot of size equivalent to the specified cast steel shot in Table 1 can be used if the shot hardness is the same or greater than the specified steel shot.

(d) Use ceramic beads only to peen local areas.

(2) When a one shot size is specified, you can use, as an alternative, a nominal size one size larger or smaller.

(3) If the shot size is not specified, or if a shot range is specified, the nominal size used is optional, but:

(a) The size used must peen to the specified intensity.

(b) The nominal size of shot used on fillet surfaces must be no larger than 1/2 the smallest fillet radius that occurs within the area to be peened, or 1/4 the diameter or width of any opening through which shot must pass to get at surfaces to be peened (such as between spring coils), whichever is smaller.

B. Shot Quality and Maintenance

(1) Keep shot (or glass or ceramic beads, as applicable) in the machine so not more than 10 percent of the particles by weight passes through the screen size specified (Table 1) for the shot size used. Sample size must be a minimum of 100 grams or 1/4 pound. Use the specified sieves or equivalent shot classifiers for shot sampling.

(2) We recommend equipment with continuous shot separation provisions to remove undersize, broken, or split shot per Paragraph 5.B.(1).

(3) When continuous shot separation is not used, screen the shot load as frequently as necessary to keep the shot quality per Paragraph 5.B.(1). For glass bead peening, screen a minimum of once per hour of continuous operation.

(4) If your equipment cannot completely replace the shot, you can have up to 5 percent by weight mix of shot of same type and hardness range, but of different size range in sizes 230 thru 460 (or equivalent). But do not mix hardened cast steel shot with other shot.

(5) Replace the shot as necessary to adjust for screening or separating losses. When you add new cast steel shot in an amount more than 35 percent of the machine hopper capacity, condition the shot load by cycling it 3 times through the machine at a grease-free steel target, to remove surface impurities and irregularities. Multiple additions of less than 35 percent of hopper capacity must be time spaced to let the machine send the added shot through the cycle three times before the next addition.

(6) Keep the shot load free of oil, grease or other contaminations that cannot be removed from peened parts by usual cleaning procedures. Vapor degrease (SOPM 20-30-03) the shot load if necessary.

Table 1: In-Process Shot Quality Standards

10% Max. Can Go Through U.S. Std. Screen Size	Cast Steel Shot Size	CRES Shot Size
8 (0.0937)	930	—
10 (0.0787)	780	—
12 (0.0661)	660	—
14 (0.0555)	550	CW-62
16 (0.0469)	460	CW-54
18 (0.0394)	390	CW-47
20 (0.0331)	330	CW-35, CW-41
25 (0.0278)	280	CW-32
30 (0.0234)	230	CW-28
35 (0.0197)	190	CW-23
40 (0.0165)	170	CW-20
45 (0.0138)	130	—
50 (0.0117)	110	—
80 (0.0070)	70	—

Glass Bead Shot Size	15% Max. Can Go Through Sieve *[1]
331	35
280	40
232	45
197	50
165	60
138	70
117	80
98	100
83	120
70	140
59	170
49	200
41	230
35	270
29	325
24	400

Table 1: In-Process Shot Quality Standards (Continued)

*[1] Sieve per RR-S-366 or JIS-Z-8801

C. Peening Area and Coverage Control

(1) If overhaul instructions specify "shot peen entire part", "shot peen all over", or equivalent notes to tell you to peen all surfaces of the part, peen all surfaces but not internal surfaces of holes smaller than 1/2 inch in diameter. When parts are peened with automatic equipment which gives a range of angles of the shot stream, intensity verification in the holes is not necessary if:

(a) The hole diameter-to-depth ratio is 1 or larger, and

(b) Surfaces adjacent to the hole get the specified intensity.

(2) If overhaul instructions specify shot peening for an internal diameter, with the adjacent area not to be peened, peen the diameter and all of its counterbores, countersinks, chamfers, etc.

(3) If overhaul instructions specify peening for both an internal diameter and the adjacent areas to different intensity levels, the related counterbores, countersinks, chamfers, etc. can be peened to either of the specified intensities.

(4) If overhaul instructions specify peening of "all exterior surfaces", peening is not necessary in holes unless additional notes specify otherwise. Web areas, the interior sides of angles, flange undercuts, all surfaces of a clevis (but not the attach holes), and areas between lugs are examples of surfaces which could be considered internal, but are actually external surfaces and are treated as such.

(5) Areas in which fadeout peening is necessary must have a gradual decrease in coverage from the area in which peening is specified.

(6) Areas in which peening is optional (or where overspray is permitted) can be:

(a) Totally unpeened.

(b) Treated as a fadeout area.

(c) Peened to any combination of intensity and coverage, but none of these two parameters can be larger than that specified for any adjacent area.

(7) In areas where shot peening is optional, no coverage examination is necessary.

(8) Areas not to be shot peened must not have indentations from the shot. To confine the shot peened areas, use masking or baffles which stay serviceable during peening. We recommend masking tape and rubber or metal baffles.

(9) After you shot peen, remove all masks and shot from the part by a procedure which will not wear down or scratch the surface.

(10) Unless shown differently, the variation in boundaries of areas to be peened, when there is a limit, must be minus zero, plus 1/8 inch.

CAUTION: WHEN YOU SHOT PEEN A REPAIRED AREA OF A SURFACE ORIGINALLY SHOT PEENED, MAKE SURE THERE IS AN OVERLAP OF AT LEAST 0.5 IN. (1.3 CM) AROUND THE EDGE OF THE REPAIRED AREA.

(11) Unless shown differently, 200% coverage is necessary in all areas where shot peening is specified. Unless shown as a range, the specified value of coverage is a minimum.

(12) The amount of coverage must be measured on the part being peened.

(13) Use a minimum of 30X magnification to find the coverage value. Peen Scan can be used to help measure the coverage.

D. Intensity Determination and Machine Settings

(1) Get and use the shot per Paragraph 5.A. and Paragraph 5.B.

(2) Unless other controls are specified by the overhaul instructions, make adjustments to the machine settings that control the intensity while you peen test strips under the shot stream with the same procedure as with the part to be peened. See Figure 2, Figure 3, and Figure 5 for details of mounting test strips. A peened test strip must not be peened again after it is removed from the holder.

(3) To give a correct intensity reading, the test strip must be peened to saturation. Saturation is that point at which two times the peening time causes a 10 percent or less increase in arc height. The arc height at the saturation point is the intensity. Coverage must be at least 100 percent on the test strip when it is peened to the specified intensity.

(4) Start with an estimated setting of the machine. Peen a series of test strips in the shot stream for different lengths of time and plot arc height versus exposure time. The shortest exposure must be for less than 100 percent coverage. Determine the saturation point by finding a 10 percent increase in the arc height curve between exposure times having a 2 to 1 ratio. If the intensity at the saturation point is not within the necessary limits, change the machine settings and try again until you get the specified intensity.

(5) Measure the Almen intensity with the central portion of the unpeened side of the test strip against the Almen gage as shown in Figure 4.

(6) When the overhaul instructions specify a single intensity of 0.005 A or higher, without a tolerance, the intensity tolerance is -0.002 A to +0.005 A. When the specified intensity is given as a range, the measured intensity must be within that range.

E. Peening of Parts

(1) After you prepared the parts per Paragraph 4. and masked them if necessary, mount and peen them with the settings made per Paragraph 5. Do not shot peen parts while they are under stress from an exterior force unless specified by overhaul instructions.

(2) The time the part is under the stream is the time for 200% coverage, as specified by Paragraph 5.C.(11). This time can be found as follows:

(a) For a given machine setting, the time for 100% coverage is a function of the hardness of the material. If the test specimen is peened for a time which gives it 100% coverage, then any material softer than the test specimen will have at least 100% coverage if peened for the same time on each equivalent area.

(b) A material harder than the test specimen must be peened longer than the test specimen to get 100% coverage.

(c) Then the time for 200% coverage is twice the time necessary to get 100% coverage.

(3) Make intensity determinations at the following minimum intervals:

(a) At the beginning or during each lot of parts. A lot is a group of parts of similar configuration, with the same peening intensity requirements and with the peened surface at the same angles compared to the stream of shot.

(b) Whenever you adjust machine settings that change the intensity: for example, nozzle air pressure, wheel speed, feed rate, shot size, distance from nozzle, etc.

(c) Every 8 hours, for continuous peening operations.

(d) Whenever you find it necessary for quality of process control.

(4) When you send in a lot of peened parts for examination, be sure to include the test specimens you used to find the intensity.

(5) When overhaul instructions do not specify peening intensity and shot size, see Table 2.

Table 2: Recommended Peening Controls

Alloy	Part Min Thickness *[1]	Intensity *[2]	Shot Size *[3]
Steels	0.05	0.002 - 0.005	230 - 780
Less than 150 ksi	0.07	0.003 - 0.006	230 - 780
	0.08	0.004 - 0.007	230 - 780
	0.10	0.005 - 0.010	230 - 780
	0.12	0.006 - 0.011	230 - 780
	0.15	0.008 - 0.013	230 - 780
	0.17	0.010 - 0.015	230 - 780
	0.20	0.012 - 0.017	230 - 780
	0.24 AND UP	0.014 - 0.019	230 - 780
Steels	0.05	0.003 - 0.005	170 - 460
150 - 240 ksi	0.07	0.003 - 0.006	170 - 460
	0.08	0.005 - 0.010	170 - 460
	0.10	0.006 - 0.011	170 - 460
	0.12	0.008 - 0.013	170 - 460
	0.14	0.010 - 0.015	170 - 460
	0.16	0.012 - 0.017	170 - 460
	0.20 AND UP	0.014 - 0.019	170 - 460

*[1] Shot peening of parts thinner than 0.08 inch is not recommended.

*[2] Peen to the specified intensities at a coverage of 200%. These intensity recommendations are applicable when both sides of a part section are peened.

*[3] Make your selection of shot size from the range shown. For example, a callout of 460-780 lets you use a shot size of 460, 550, 660, or 780. Refer to Paragraph 5.A.(3) above for more data.

Table 3: Recommended Peening Controls

Alloy	Part Min Thickness *[1]	Intensity *[2]	Shot Size *[3]	Glass or Ceramic Bead Size *[3]
Steels	0.05	0.005 - 0.010	170 - 460	–
270 - 300 ksi	0.06	0.006 - 0.011	170 - 460	–
	0.08	0.008 - 0.013	170 - 460	–
	0.10	0.010 - 0.015	170 - 460	–
	0.12	0.012 - 0.017	170 - 460	–
	0.15 AND UP	0.014 - 0.019	170 - 460	–
Al Alloys *[4]	0.05	0.002 - 0.004	230 - 550	83 - 331

Table 3: Recommended Peening Controls (Continued)

Alloy	Part Min Thickness *[1]	Intensity *[2]	Shot Size *[3]	Glass or Ceramic Bead Size *[3]
	0.06	0.003 - 0.005	230 - 550	165 - 331
	0.08	0.004 - 0.007	230 - 550	165 - 331
	0.10	0.005 - 0.010	230 - 550	165 - 331
	0.13	0.006 - 0.011	230 - 550	331
	0.16	0.008 - 0.013	230 - 550	*[5]
	0.19	0.010 - 0.015	230 - 550	*[5]
	0.23	0.012 - 0.017	230 - 550	*[5]
Ti Alloys	0.05	0.003 - 0.005	230 - 460	117 - 331
	0.07	0.003 - 0.006	230 - 460	117 - 331
	0.08	0.004 - 0.007	230 - 460	117 - 331
	0.10	0.005 - 0.010	230 - 460	117 - 331
	0.12	0.006 - 0.011	230 - 460	117 - 331
	0.15	0.008 - 0.013	230 - 460	*[5]
	0.17	0.010 - 0.015	230 - 460	*[5]
	0.20	0.012 - 0.017	230 - 460	*[5]
	0.24	0.014 - 0.019	230 - 460	*[5]

*[1] Shot peening of parts thinner than 0.08 inch is not recommended.

*[2] Peen to the specified intensities at a coverage of 200%. These intensity recommendations are applicable when both sides of a part section are peened.

*[3] Make your selection of shot size from the range shown. For example, a callout of 460 - 780 lets you use a shot size 460, 550, 660, or 780. Refer to Paragraph 5.A.(3) above for more data.

*[4] See Table 4 for recommended controls to peen aluminum alloy cylinders before they are hard anodized.

*[5] Intensities higher than 0.007 are not usually possible with glass beads.

Table 4: Recommended Peening Controls for Aluminum Alloy Cylinders Before Hard Anodizing

Minimum Wall Thickness (Inches) *[1]	Minimum Cylinder Diameter (Inches)	Shot Size *[2]	A2 Intensity *[3]
0.100-0.250	Less than 2.00	170 - 230	0.008 - 0.011
	2.00 - 3.00	190 - 280	
	More than 3.00	230 - 280	
0.251-0.500	Less than 2.00	170 - 230	0.010 - 0.013
	2.00 - 3.00	190 - 280	

Table 4: Recommended Peening Controls for Aluminum Alloy Cylinders Before Hard Anodizing (Continued)

Minimum Wall Thickness (Inches) *[1]	Minimum Cylinder Diameter (Inches)	Shot Size *[2]	A2 Intensity *[3]
	More than 3.00	230 - 460	
	Less than 2.00	170 - 230	0.012 - 0.015
More than 0.500	2.00 - 3.00	190 - 280	
More than 0.500	More than 3.00	230 - 460	0.012 - 0.015

*[1] If the ratio of maximum to minimum wall thickness is 2:1 or greater, cylinder distortion could occur. Extra honing stock could be necessary in such cases. Distortion can be worse for 2XXX series alloys than for the 7XXX series.

*[2] Smaller shot sizes could be necessary to get into internal radii, to make the part more resistant to fatigue. Cut stainless steel wire shot of equivalent size can be used.

*[3] Peen to the specified intensities at a coverage of 200%.

6. POST PEENING PROCEDURES

A. After peening, all masking and shot must be removed from the part by a method which will not erode, scratch, or otherwise damage the surface.

B. After shot peening, surface roughness can be decreased, without overhaul instructions, by:

(1) A secondary shot peening operation at a lower intensity, with the same or larger shot of the same type as you used before and with additional coverage up to 600%.

(2) Light honing, abrasive lapping, hand sanding or abrasive belt polishing of the shot peened surface per BAC5492 (SOPM 20-10-07) for titanium, BAC5440 (SOPM 20-10-02) for alloy steel 180 ksi or above, or BAC5748 (SOPM 20-30-03) for other metals, if the surface is not heated above the limits of Paragraph 6.C.(1). Unless specified by the overhaul instructions, the amount of material removed must not be more than 10 percent of the nominal Almen A intensity or 0.001 inch, whichever is larger. If the amount of material removed is more than this, peen the affected area again to the original shot size, intensity, and coverage requirements. As an option to, or as an alternative, you can:

(a) Peen with glass beads to original intensity and coverage, if the originally specified intensity was not more than 0.007A.

(b) Flap peen to the original intensity and coverage requirements.

C. No manufacturing operations or treatments which relieve stresses developed by peening or develop detrimental residual stresses are permitted after shot peening. Examples are:

(1) Heat treating, stress relieving, bonding, or any other process which causes heating above the following temperatures:

(a) Low alloy steels (tempered below 475°F), 300°F

(b) Low alloy steels (tempered at or above 475°F), 400°F

(c) Precipitation hardened (PH) CRES, 475°F

(d) Cold worked 300-series CRES, 475°F

(e) All other CRES, 750°F

(f) Aluminum alloys, 200°F

(g) Titanium alloys, 475°F

(h) Nickel and cobalt alloys, 1000°F

(2) Grinding

(3) Etching or abrasive blasting that removes more material than that permitted by Paragraph 6.B.(2) above.

(4) Forming and straightening by means other than peen forming (BAC5730-1).

D. After peening, clean parts as follows (unless the parts will get chemical treatment that will remove residues):

(1) Alloy steels (less than 220 ksi) – Abrasive clean per BAC5748, or clean per BAC5751 (SOPM 20-30-03).

(2) Alloy steels (220 ksi and above) – Abrasive clean per BAC5748 (SOPM 20-30-03).

(3) Titanium alloy – Clean per BAC5753 method 2, and dry grit blast per BAC5748, Type 2 (SOPM 20-30-03).

(4) Aluminum alloy – Clean per BAC5765. (Use method 1, solution 3 on glass-bead-peened aluminum.)

(5) CRES steels – Clean per BAC5625 (SOPM 20-30-03).

(6) Nickel and cobalt alloys – Clean per BAC5758 (SOPM 20-30-03).

E. Give peened parts protection from corrosion per (SOPM 20-44-02) until final coatings are applied.

F. Apply all protective finishes after shot peening, unless otherwise specified noted by the overhaul instructions.

G. Do not make scribe marks on shot peened surfaces.

7. SELF-CONTAINED SHOT PEENING (BAC5730-2)

WARNING: EYE PROTECTION MUST BE USED AT ALL TIMES DURING SHOT PEENING OPERATIONS.

A. General

(1) This procedure describes shot peening of relatively small areas of metal surfaces for the purpose of imparting a compressive layer.

(2) The techniques employed contain the shot on the tool and prevent contamination of the surrounding area with loose shot.

(3) Refer to other paragraphs of this manual for more general details.

B. Wheel Preparation

(1) Assemble the peening wheel components as shown in Figure 6.

(2) If the wheel is new, its shot could have adhesive on it. To be sure the adhesive is gone before you use the wheel, clean the surface of the shot with 320-400 grit silicon carbide or aluminum oxide paper.

C. Intensity Determination

(1) Mount an Almen test strip in position with a magnetic specimen holder.

(2) Use a wheel per Table 5.

(3) Start with a wheel speed per Figure 8.

(4) Peen a series of Almen test strips for different exposure times. Peen the first strip to give it less than 90% coverage. The intensity is the point at which two times the peening time causes 10% or less increase in arc height. The coverage must be at least 100% on the strip that has the specified intensity.

NOTE: To find the distance between the tool and the surface, lower the tool (with the wheel at the specified speed) onto the workpiece until you feel a strong resistance. Keep this distance during peening. Hold the tool to keep the mandrel parallel to the surface of the part. Move the tool around during peening to prevent unwanted score marks on the work. Arc height of a strip peened in a magnetic holder must be multiplied by 0.77 to get the equivalent Almen intensity.

(5) If the corrected Almen intensity is not within the intensity range specified or within -0.002 and +0.003 of a single specified intensity, adjust the wheel speed and do Paragraph 7.C.(1) thru Paragraph 7.C.(4) again with a new Almen test strip.

Table 5: Peening Wheel Selection

Wheel Designation	Shot Size and Type	Minimum Hole Diameter that may be Peened
1 x 2	330 Tungsten Carbide	1.25 inch
9/16 x 1-1/4	330 Tungsten Carbide	0.75 inch

D. Peening Production Parts

(1) Remove all paint, plating, conversion coating and surface contamination (grease, oil, etc.) from the area to be peened as follows:

(a) Paint – BAC5725 (Stripping Organic Finishes in SOPM 20-30-02)

(b) Plating and Conversion Coating – BAC5771 (Stripping Inorganic Finishes in SOPM 20-30-02)

(c) Surface Contamination – BAC5744 and/or BAC5750 (Manual Cleaning in SOPM 20-30-03)

(2) Use the same tool speed and distance between the tool and the work surface as you used to find the intensity in Paragraph 7.C.

(3) Peen parts for two times the length of time necessary to get full surface coverage and Almen strip saturation to get 200% coverage. To make sure, visually examine the surface of the part at 10X magnification to see that all of the original surface is replaced with overlapping indentations. A test panel of the same chemical composition and hardness as the part can be used as an alternative to the part to get to know the coverage.

(4) To flap peen holes, find the correct wheel speed from Table 6.

E. Flap Wheel Maintenance

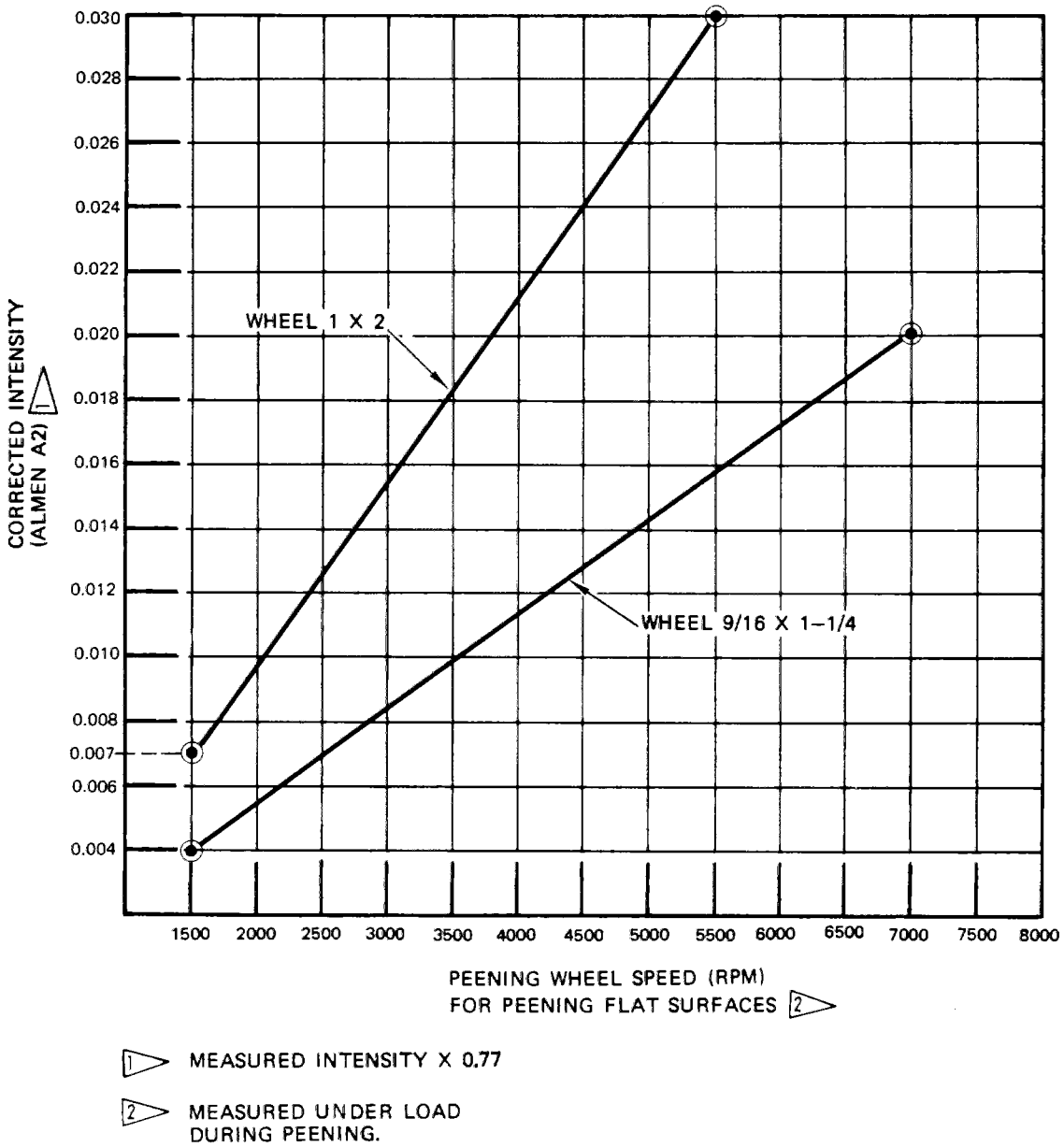
(1) Replace the flap wheel when more than 20% of its shot is gone.

(2) Condition new wheels per Paragraph 7.B.(2). If you replace a wheel during a peening operation, it is not necessary to do the intensity procedure of Paragraph 7.C. again.

F. After peening, solvent clean the area by hand per BAC5750 (SOPM 20-30-03) to remove unwanted matter.

Table 6: Conversion Chart for Determining Wheel Speeds Needed When Peening Small Holes with 9/16 x 1-1/4 Roto Peen Wheel

Flat Surfaces	Hole Diameter (Inch)						
	0.75-0.79	0.80-0.85	0.86-0.91	0.92-0.97	0.98-1.07	1.08-1.19	1.20 & Over
	Wheel Speed (rpm)						
1500	2700	2500	2300	2100	1900	1600	1500
2000	3600	3300	3000	2800	2600	2300	2000
2500	4500	4100	3700	3400	3200	2800	2500
3000	5300	4900	4500	4100	3800	3400	3000
3500	6200	5700	5200	4700	4400	3900	3500
4000	7100	6500	5900	5500	5100	4500	4000
4500	–	–	6600	6100	5700	5000	4500
5000	–	–	–	6800	6300	5600	5000
5500	–	–	–	–	6900	6100	5500
6000	–	–	–	–	–	6700	6000
6500	–	–	–	–	–	–	6500
7000	–	–	–	–	–	–	7000



Corrected Intensity vs Peening Wheel Speed
Figure 8