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Almen Strip Specifications

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A Brief History of the Almen Strip

Since the invention of the Almen strip and Almen gage by J. O. Almen in 1942 the shot peening and blast cleaning industries have had a simple, inexpensive and reliable tool to gage shot blast stream intensity. Basically, the Almen strip is a small (3 inch by 3/4 inch) piece of spring tool steel that is blasted on one side and made to curve in response to the intensity of the impinging blast stream. The original strip thickness was 0.050 inch and had no letter designation until the "B" strip was developed. Although there doesn't seem to be any remaining records of the "B" strip, it can be surmised that it was quickly replaced by the "C" strip with thickness of 0.094 inch for higher intensity applications of the automotive sector. (It's not clear when the "A" strip thickness changed from Almen's 0.050 inch patent to the present value of 0.051 inch.)

Thus the "A" and the "C" strip were in common usage, primarily in the automotive industry. Eventually a thinner strip was needed for lower intensity peening of aircraft structural parts and accordingly Nobel from Pratt & Whitney developed a strip of 0.031 inch thickness and the "N" strip was introduced.

The most popular documents for controlling the characteristics of the Almen strip are the U. S. Government specification Mil-S-13165 and and the Society of Automotive Engineers (SAE) J-442. The government specification dates back to August 31, 1944 when a document number AXS-1272 was published to describe a new technology for use by the U. S. Army. This document then evolved into Mil-S-13165 which was first issued on December 11, 1953. The Almen strip attributes in Mil-S-13165 Revision C are unchanged from AXS-1272.

The Society of Automotive Engineers, SAE, was also active in preparing Almen strip specifications. Their primary control document is SAE J-442 with supplemental specifications for aerospace applications coming from SAE AMS-2430 and SAE AMS 2432. Unfortunately, the evolution of J-442 allowed the strip attributes to change relative to Mil-S-13165. See Table 1 below.

Since shot peening often makes a dramatic improvement in a metallic part's performance, much of the early peening was done secretly. Eventually proprietary peening specifications evolved to "enhance" the peening process beyond the customary specifications. Automotive, aerospace airframe and engine manufacturers were all active in promoting variations in the Almen strip specifications.

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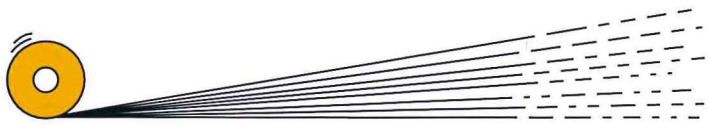
Table 1. U. S. Industry Shot Peening Specifications

Spec	Date	Length	Width	Thickness	Hardness	Flatness
13165C	June 1989	3.000±.015	.745-.750	.051±.001	44-50	±.0015
SAE J-442	June 1961	3.000±.015	.745-.750	.051±.001	44-50	±.0010
SAE J-442	Aug. 1979	2.992±.016	.744-.748	.051±.001	44-50	±.0010
SAE J-442	Jan. 1995	2.992±.016	.742-.750	.051±.001	44-50	±.0010
AMS 2430L	July 1993	2.992±.016	.742-.750	.051±.001	44-50	±.0010
AMS 2432B	Aug. 1996	2.992±.016	.742-.750	.051±.0005	45-48	±.0005



Continued from page 1

Table 2 shows the Almen strip characteristics of hardness, length, width, thickness and flatness requirements. Only the "A" thickness strips are included in the table. It can be surmised that hardness and flatness variations reflect a desire for more consistent and accurate intensity measurements. SAE aerospace specification AMS-2432 was based upon SAE J-442 with enhanced hardness and flatness tolerance for the more critical peening applications using computer monitored equipment.

Electronics Inc. Almen Strip Grading and Inspection

The following narrative will describe how Electronics Incorporated became involved in supplying Almen strips and how they developed multiple grades intended to meet the various specifications. (See Table 3 on page 10.)

Electronics Inc. began selling Almen strips in 1989 to help underwrite the cost of *The Shot Peener Newsletter*. As a result of Almen strip specifications' diversity, Electronics Incorporated developed three grades of strips that allowed users to choose the price/performance level best suited to them. Grade 3 strips were guaranteed to meet Mil-S-13165C specifications and were bulk packaged in bags of 1000 pieces without special inspection or measurement. Grade 2 Almen strips were packaged in specially designed smaller protective boxes of 50 strips, had excess oil removed and were inspected for nicks, scratches, burrs, length and width. It was found to be very important not to remove the oil, especially by vapor degreasing or similar technique since the strips are prone to rusting, even in a sealed zip-lock type bag. Grade 1 strips were 100% inspected for flatness to the more stringent SAE J-442 requirement (±.001 inch) and each lot of 1000 strips were sample inspected for hardness. When SAE aerospace created AMS-2432, a special grade of strip was required and grade 1S was developed. Again, the strips were 100% inspected for flatness (±.0005) and each lot of 1000 was sample inspected for hardness (45-48 Hrc).

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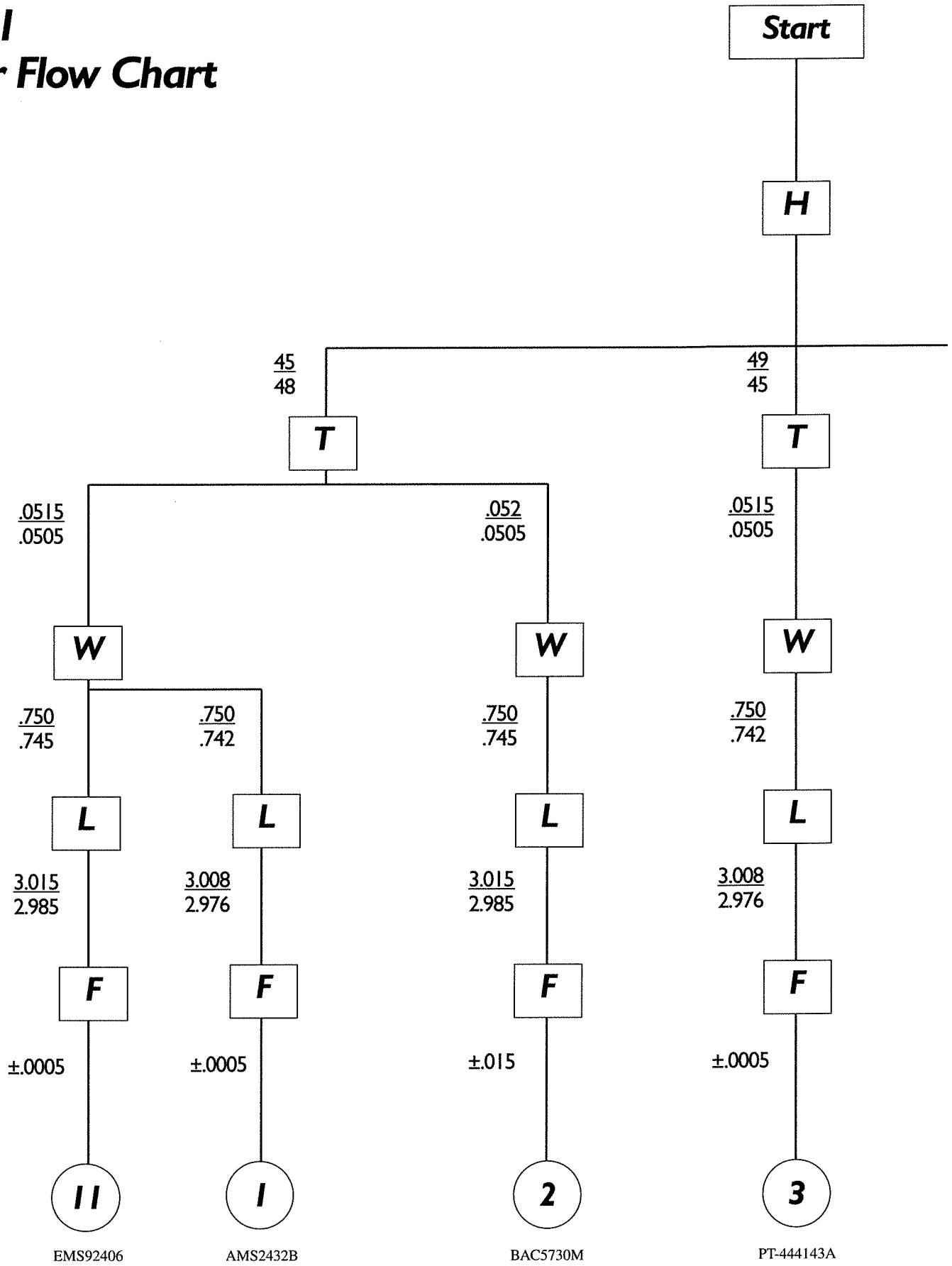
Table 2. Almen "A" Strip Specifications Comparison

#	Owner	Specification		Date	Length	Width	Thickness	Hard	Flat
1	SAE	AMS2432	B	Aug 1996	2.992±.016	.742-.750	.051±.0005	45-48	±.0005
2	Boeing	BAC 5730	M	Mar 25, 1992	3.000±..015.	.745-.750	.051±.001	45-48	±.0015
3	Pratt & Whitney	PT-444143	A		2.992±.016	.742-.750	.051±.0005	45-49	±.0005
4	General Electric	P11TF8	S5	Nov 29, 1994	3.000±.015	.745-.750	.051±.001	44-50	±.0005
5	U. S. Army	Mil-S-13165	C	Jun 7, 1989	3.000±.015	.745-.750	.051±.001	44-50	±.0015
5	BAe	BAEP 2009		Jan 1990	3.000±.015	.745-.750	.051±.001	44-50	±.0015
5	deHavilland	PPS 17.03	4	Jan 22, 1987	3.000±..015	.745-.750	.051±.001	44-50	±.0015
5	General Dynamics	FPS-1032		Sep 30 1963	3.000±.015	.745-.750	.051±.001	44-50	±.0015
5	General Electric	P11TF3	12	Nov 29, 1994	3.000±.015	.745-.750	.05±.001	44-50	±.0005
5	General Motors	GM 4283-P		Feb 1966	3.000±.015	.745-.750	.051±.001	44-50	±.0015
5	Hamilton Standard	HS102	H	Jan 15, 1991	3.000±.015	.745-.750	.051±.001	44-50	±.0015
5	Sikorsky	SS8767	3	May 15, 1969	3.000±.015	.745-.750	.051±.001	44-50	±.0015
6	SAE	J-442 (61)		Jun 1961	3.000±.015	.745-.750	.051±.001	44-50	±.001
6	U. S. Army	Mil-P-81985		Oct 18, 1974	3.000±.015	.745-.750	.051±.001	44-50	±.001
6	Bell Helicopter	BPS FW 4409	B	Nov 21, 1979	3.000".015	.745-.750	.051±.001	44-50	±.001
6	Hawker Siddeley	S.29.46	2	Apr 1977	3.000±.015	.745-.750	.051±.001	44-50	±.001
7	SAE	AMS2430	L	Jul 1993	2.992±.016	.742-.750	.051±.001	44-50	±.001
7	SAE	J-442 (95)		Jan 1995	2.992±.016	.742-.750	.051±.001	44-50	±.001
7	Pratt & Whitney	70-41-02		Oct 1, 1991	2.992±.016	.742/.750	.051±.001	44-50	±.001
7	Pratt & Whitney	TAM-34744	J		2.992±.016	.742-.750	.051±.001	44-50	±.001
8	SAE	J-442 (79)		Aug 1979	2.992±.016	.744-.748	.051±.001	44-50	±.001
8	Intl. Harvester	A-39		May 1978	2.992±.016	.744-.748	.051±.001	44-50	±.001
9	Lockheed-Georgia	MPS 7340I		Nov. 1, 1978	3.000±.015	.745-.750	051±.001	44-50	±.0003
9	Lockheed Georgia	STP51-501	J	Oct 15, 1975	3.000±.015	.745-.750	.051±.001	44-50	±.0003
10	ASTM	B 851-94		May 1994	2.992±.016	.744-.748	.051±.001	44-50	±.0015
11	AiResearch	EMS92406		Apr 18, 1990	3.000±.015	.745-.750	.051±.0005	45-48	±.0005
12	Snecma	AMN 332/86		Jun 30, 1986	3.000±.016	745-.751	.051±.001	44-50	±.001

Figure 1
Master Flow Chart



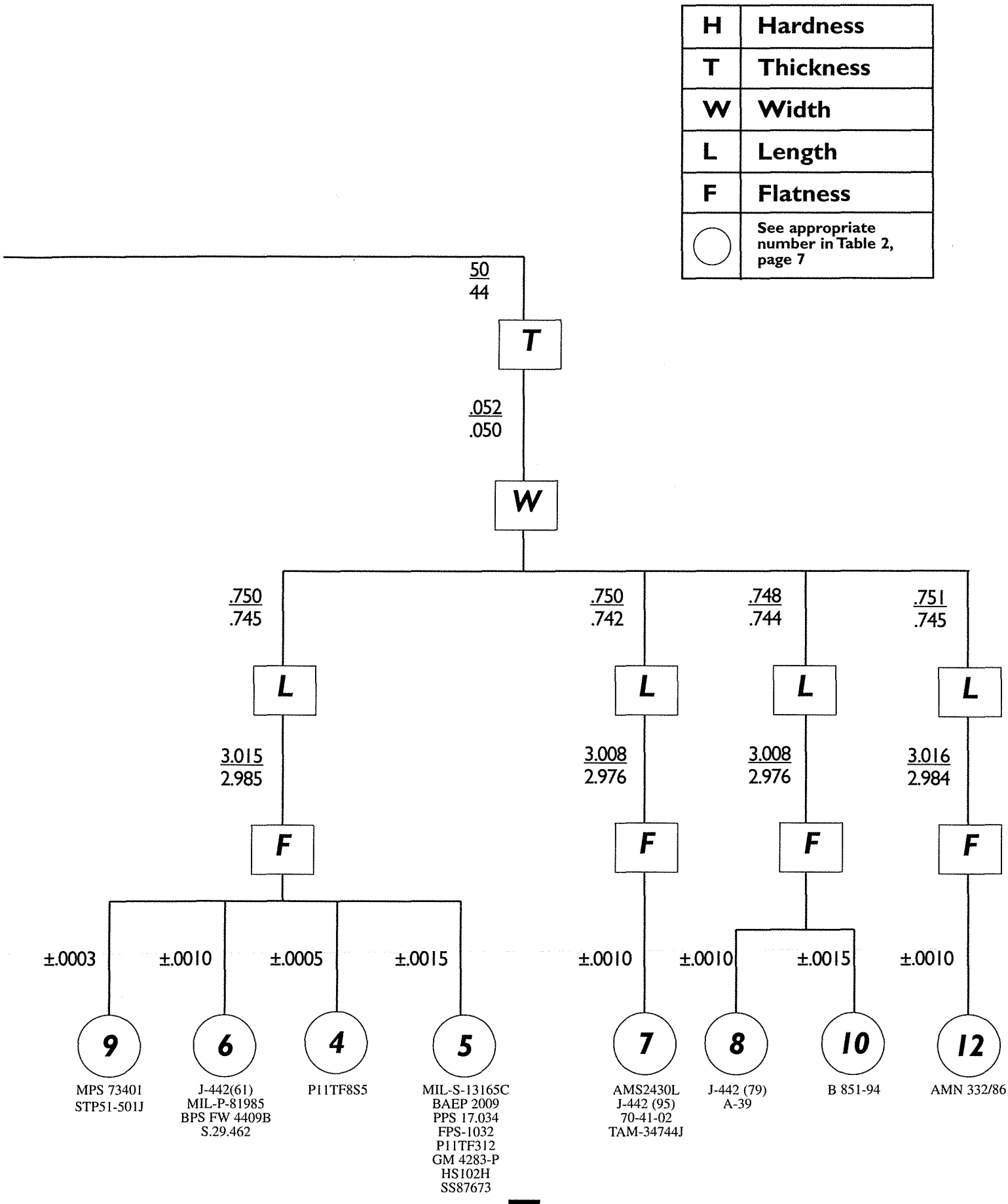

H Hardness
T Thickness
W Width
L Length
F Flatness
See appropriate number in Table 2, page 7
50
44
T
.052
.050
W
.750
.745
.750
.742
.748
.744
.751
.745
L
L
L
L
3.015
2.985
3.008
2.976
3.008
2.976
3.016
2.984
F
F
F
F
±.0003
±.0010
±.0005
±.0015
±.0010
±.0010
±.0015
±.0010
9
6
4
5
7
8
10
12
MPS 73401
STP51-501J
J-442(61)
MIL-P-81985
BPS FW 4409B
S.29.462
P11TF8S5
MIL-S-13165C
BAEP 2009
PPS 17.034
FPS-1032
P11TF312
GM 4283-P
HS102H
SS87673
AMS2430L
J-442 (95)
70-41-02
TAM-34744J
J-442 (79)
A-39
B 851-94
AMN 332/86

Table 3. Electronics Inc. Grade Table

Grade 3	Bulk packaged (meets Mil-S-13165)
Grade 2	50 pcs. packaged, minor inspection
Grade 1	as above, flatness 100% inspected to .001 inch
Grade 1S	as above, flatness 100% inspected to .0005 inch

It wasn't long after these four grades were established that special requests for other variations arose. Boeing requested a variation that didn't fall into the standard categories. General Electric asked for another variation, and differences in the Pratt and Whitney specifications were noticed. Someone noticed that SAE J-442 length, width and thickness didn't match the Mil-S-13165 dimensions when the metric measurements were converted to inch measures. The multitude of variations prompted the development of Table 2 which shows 12 distinct Almen strip requirements.

The master flow chart shown in Figure 1 (pages 8 and 9) helps to visualize the differences required by the various specifications. At least 12 distinct specifications were identified for this article. To further illustrate the differences in individual attributes Figures 2 through 6 help to quantify the individual attributes of hardness, thickness, width, length and flatness.

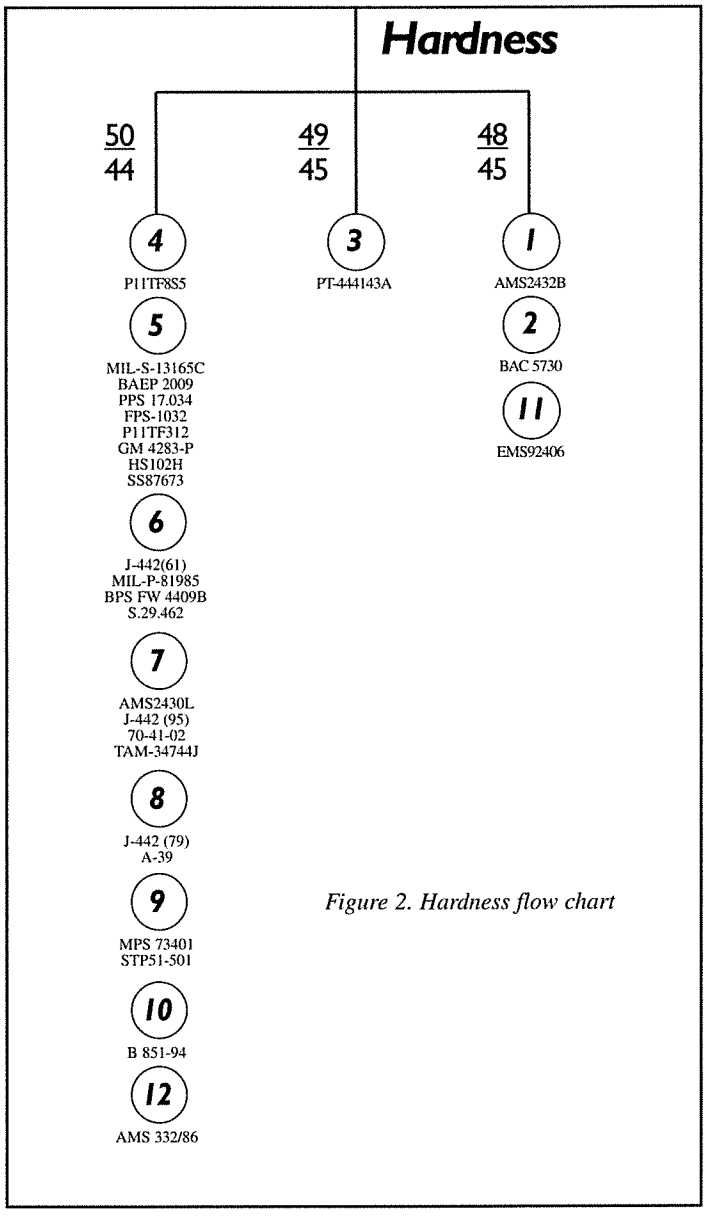


Figure 2. Hardness flow chart

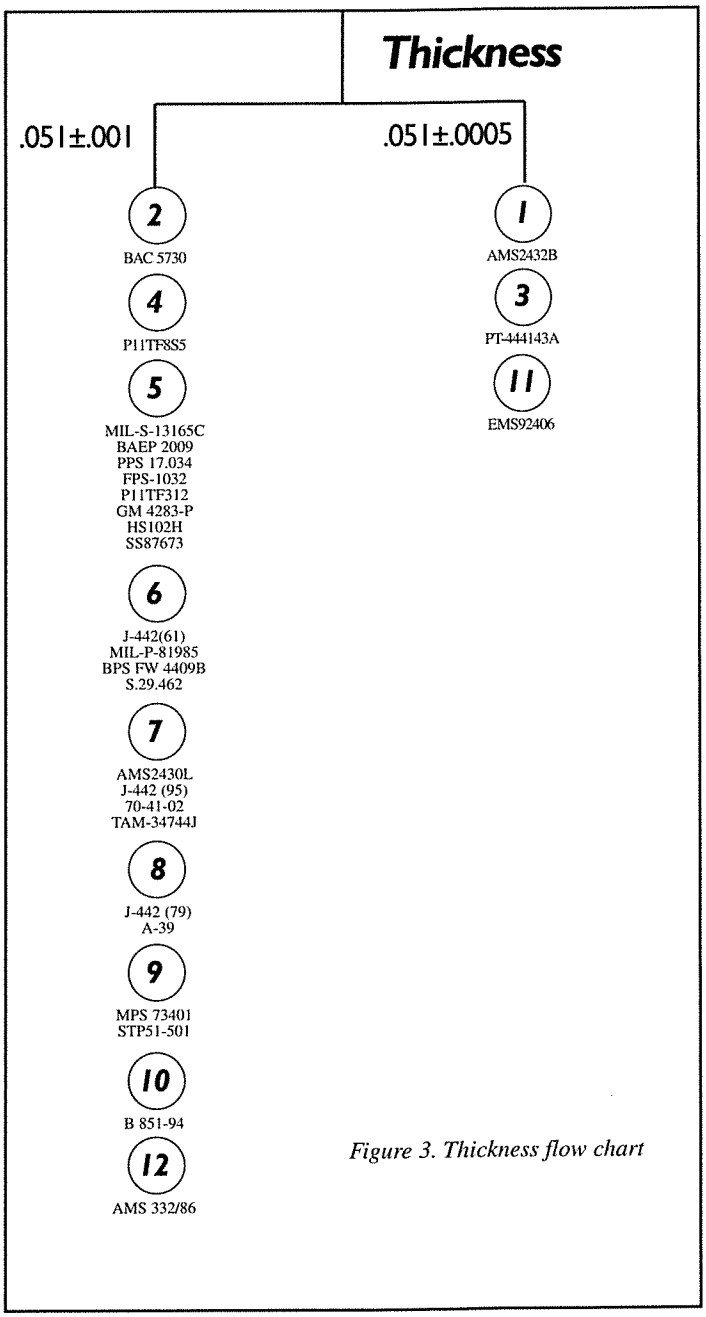


Figure 3. Thickness flow chart

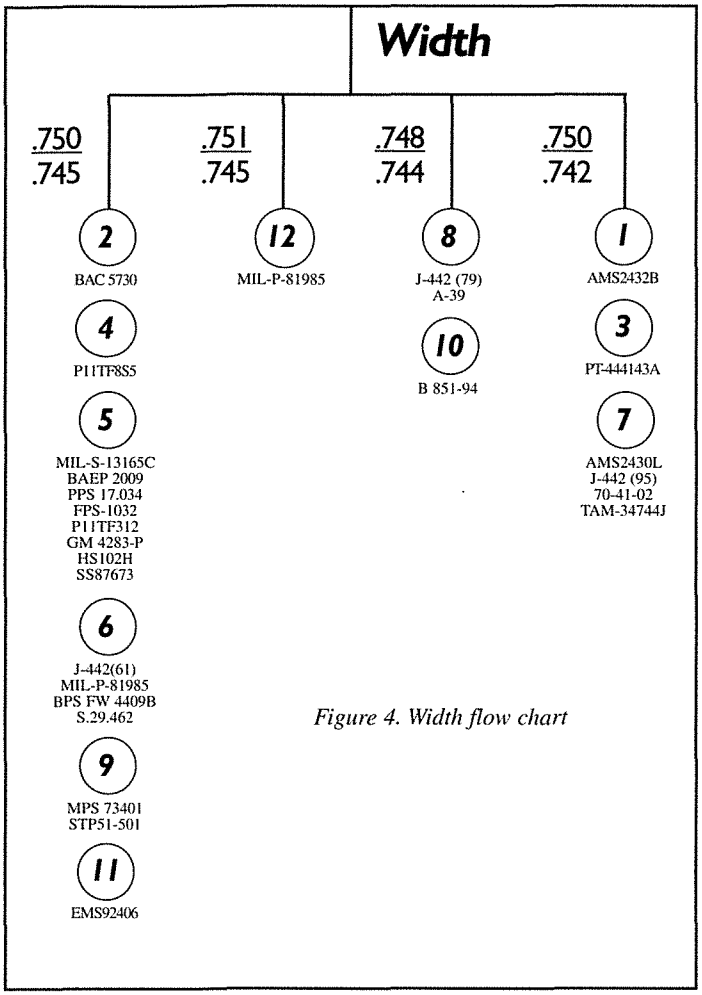


Figure 4. Width flow chart

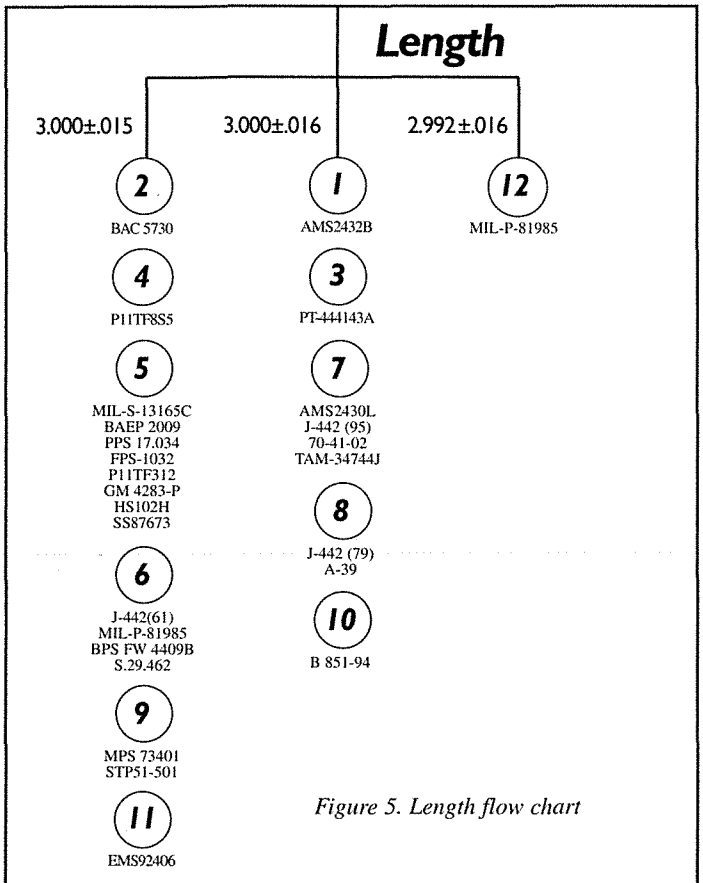


Figure 5. Length flow chart

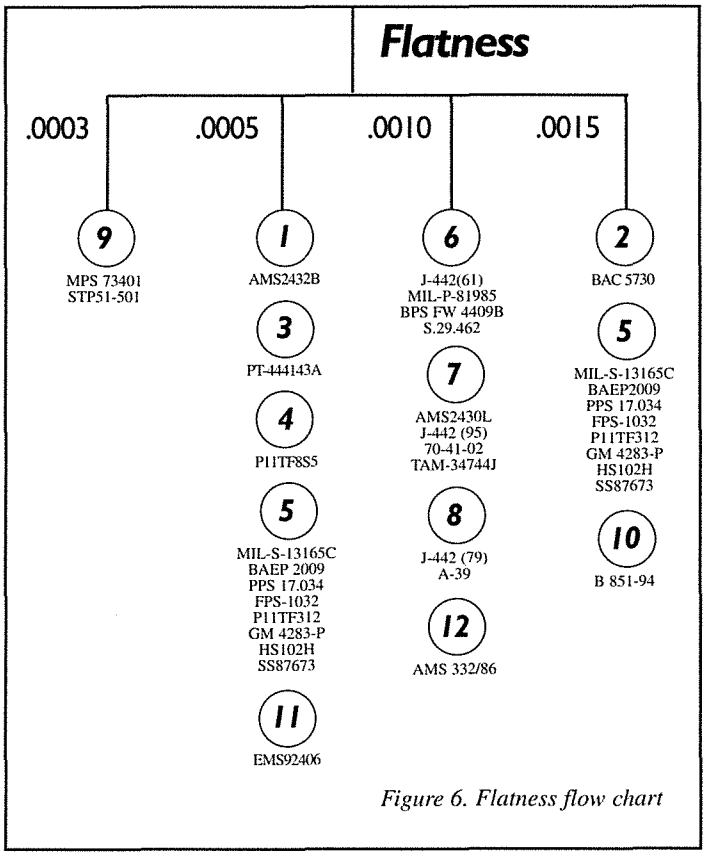


Figure 6. Flatness flow chart

To help satisfy the various (and occasionally conflicting) requirements, Electronics Incorporated began charting histograms of the length, width, thickness, hardness and flatness attributes (30 piece sample per lot of 1000 strips based upon MIL STD 105 inspection requirements). The histograms, shown in Figures 7 through 11, provide the information needed to certify that strips will meet any of the specifications that might be required.

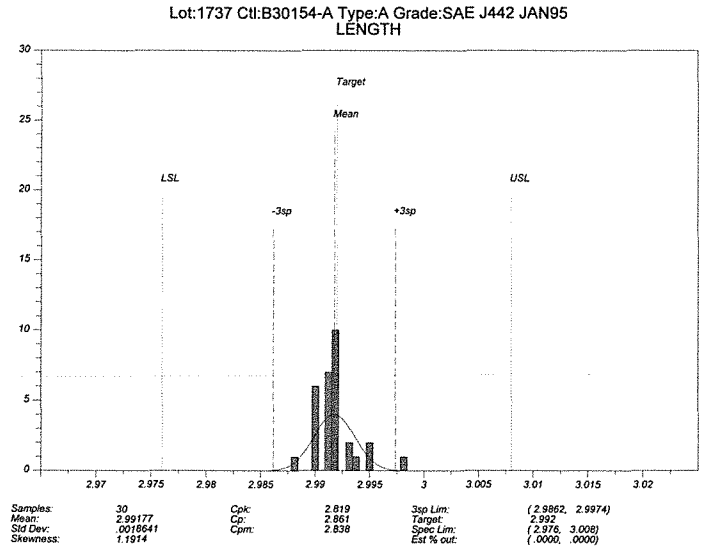


Figure 7. Length Histogram

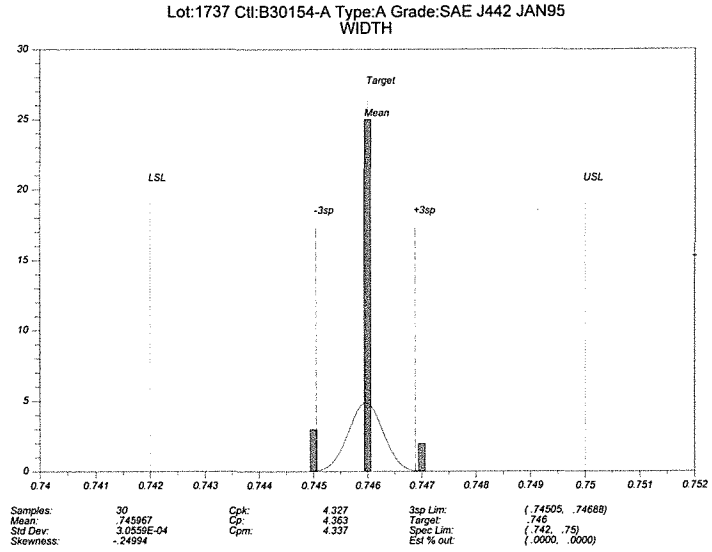


Figure 8. Width Histogram

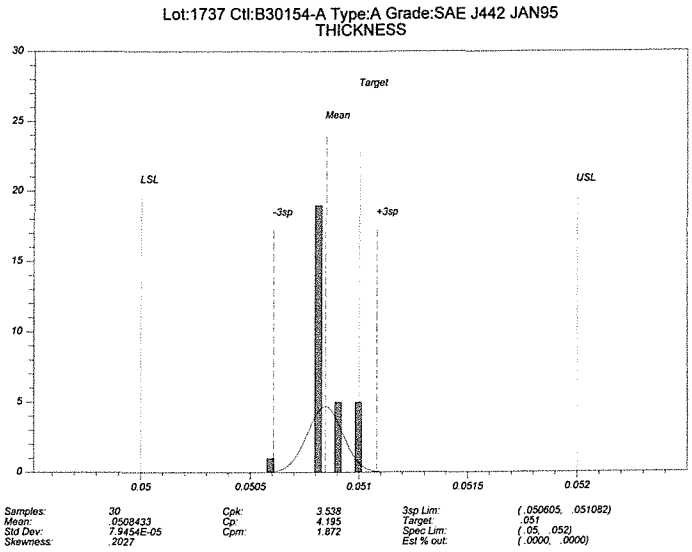


Figure 9. Thickness Histogram

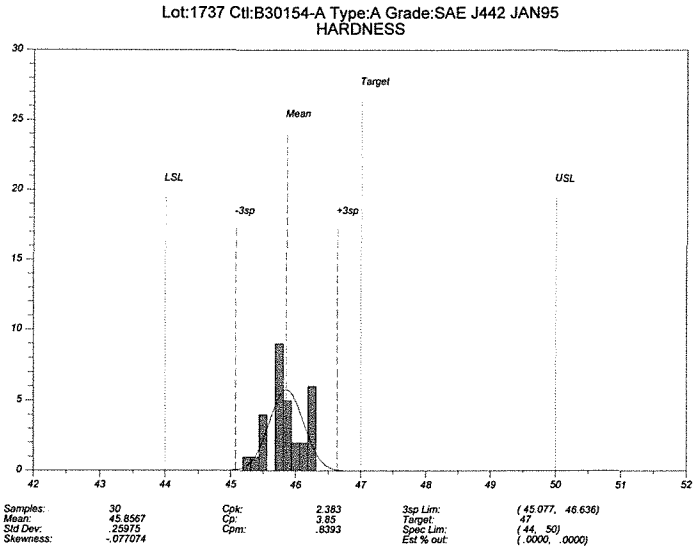


Figure 10. Hardness Histogram

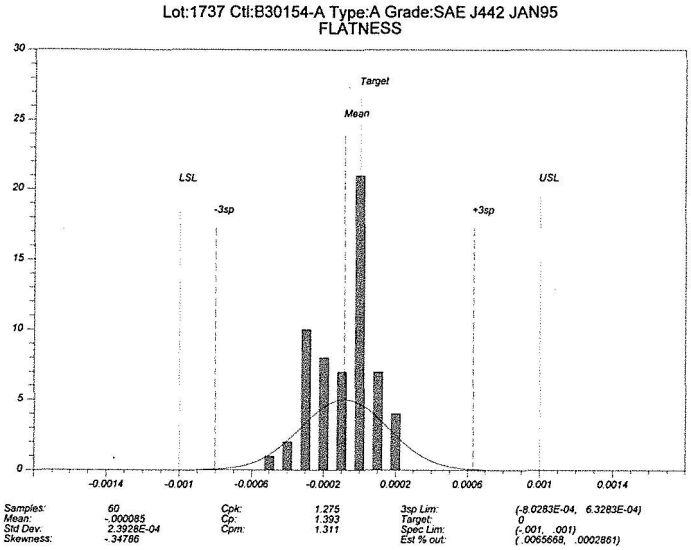


Figure 11. Flatness Histogram

Conclusion

If you were wondering what is done to inspect and ship Almen strips to meet the increasing demands of a growing industry, now you know the rest of the story. It has become necessary to continually review Almen strip specifications to assure proper compliance with the requested attributes. Assumptions about Almen strip quality and outdated practices of "rejecting for non-compliance" have been replaced with modern techniques of statistical process control as verified by sample histograms. Requests for tighter hardness range (i.e. 45-48 Hrc) or tighter flatness tolerance (i.e. ±.0003 inch) are now easily met. The certification that is provided with the Almen strip shipment provides the customer assurance that he will be using Almen strips that do, indeed, meet all applicable requirements and specifications.

Caution: Every attempt has been made to insure the accuracy of this article but the author makes no claims as to its accuracy. Any and all specifications are subject to revision without the author's knowledge. Any corrections received by the author will be reprinted in the next issue of *The Shot Peener*. The information presented in this article is meant to be illustrative and should not be relied upon for the performance of any peening or cleaning contracts.