



Specification No.: 332
 Issue Date: 11-1-74
 Revision Date: (B) 09-03-02

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**PRODUCT SPECIFICATION
 HI-SET® FASTENING SYSTEM**

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REVISION (B)

Entire Document: Re-typed with editorial changes to bring to current format;
 Changed Hi-Set Rivet(s) to Hi-Set fastener(s).
 Changed 'Lot Acceptance' to 'Quality Assurance Inspection'
 Removed references to titanium, titanium material and heat treatment specifications, and titanium specific tests (i.e. surface contamination, hydrogen embrittlement)
 Merged Tables II and III into Table II
 Table V was Table IX
 Table VI was Table V
 Table VIII was Table X
 Table IX was Table VI
 Table X was Table VII
 Replaced MIL-I-6866 with ASTM E 1417
 Replaced MIL-STD-105 with ANSI / ASQC Z1.4

Additional changes:
 Page 3 Section 1.1 Scope: Chief Engineer to Director of Engineering
 Section 1.2 Application: Added second sentence 'The Hi-Set fastener shall be . . .
 Section 2.0 Applicable Documents:
 Removed QQ-P-35
 Added MIL-STD-171
 Added AMS-H-6875
 Added ASTM-E-29

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- Removed HS No. 124, 121, 36
- Removed NAS 526 and NAS 527
- Added NASM-1312
- Added HS 333 and HS400
- Page 4 Section 3.0 Replaced entire Requirements Section to refer to Table 1 only.
- Page 4 Section 4.1 Changed 'three years' to 'seven years'
- Section 4.3.1 Added reference to Table III (recommended qualification inspection matrix).
- Page 5 Section 4.4.2 Added last sentence: "Selection of the sample pieces for inspection shall be..."
- Page 5 Table I Heads: moved bearing surface perpendicularity requirement to Table IV, moved upset forging method requirement to Table IX.
- Heat Treatment: added 'heat treatment and mechanical working shall develop shear properties without adverse effect on metallurgical properties, as defined herein'
- Finish: replaced with 'as specified on applicable standard drawing'
- Mechanical Performance: replaced '...herein' with '... in Tables II and VI'
- Metallurgical Characteristics: was 'Rivets shall be examined for metallurgical characteristics as specified herein'
- Dimensional Control: added '... and additional dimensional requirements of Table IV.'
- Moved 'Discontinuities, General', 'Head Discontinuities', 'Microstructure' and 'Grain Flow' to Table IX
- Table II Installation: replaced '... Hi-Shear instruction manuals' with 'Hi-Shear Specification 333'
- Merged 'Qualification Tests with Samplings' and 'Lot Acceptance Inspection' Tables into Table II
- Removed Material and Heat treatment rows (covered by Table I and paragraph 4.3.2).
- Set qualification sample size to 24.
- Page 6 Table III New Table (Recommended qualification inspection matrix)
- Table IV Added 'Requirements' column and replaced 'Procedure' with 'Inspection Method'
- Head Height (flush heads): replaced NAS527 with .65%AQL under 'Sampling Plan', replaced NAS 526 with HS400.
- Removed 'grip' row (no inspectable features)
- Added ASTM-E-29 note
- Page 7 Table VI Added tensile strength and insertion test requirements
- Merged qualification and Production lot acceptance columns
- Added tolerance to grip requirements
- Added Note (e) (ASTM-E-29 significant digits)
- Page 8 Table VII New Table (Insertion Test Requirements)
- Table VIII Replaced all notes with Note 1. Information from other notes covered in Table VI and Table IX
- Page 9 Table IX Incorporated Requirements column, split out Sampling and Criteria into separate columns, incorporated notes from Table VIII
- Page 10 Table X Removed 'Any location except head-to-shank fillet' row. Covered in Table IX.
- Added Note (ASTM-E-29).
- Removed Figure 1 (Shear Fixtures), not necessary. Added new Figure 1 (Tension Test fixture)



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1.0 SCOPE AND APPLICATION

1.1 Scope

This specification defines the engineering and inspection requirements for Hi-Set fasteners procured under part numbers listed on Hi-Shear drawings, which refer to this specification. Receiving contractors may reject any lot that does not conform. Recommendations concerning improvements or corrections to this specification should be directed to the Director of Engineering of Hi-Shear Corporation.

1.2 Application

The Hi-Set fasteners covered by this specification are intended for use in applications requiring fastener shear strengths of 95 KSI at room temperature. The Hi-Set fastener shall be inserted from one side of the assembly and the installation completed by forming the upset head against the opposite side per the requirements of Hi-Shear specification 333.

2.0 APPLICABLE DOCUMENTS

The following documents, of the issue in effect on the date of price inquiry, form a part of this specification to the extent indicated. In case of conflict, this specification takes precedence.

Federal Specifications

PPP-B-566 Boxes, paperboard folding.
PPP-B-665 Boxes, paperboard metal-stayed.

Military Standards

MIL-STD-129 Marking for Shipment and Storage.
MIL-STD-171 Finishing of Metal and Wood Surfaces.

Aerospace Material Specifications

AMS5731 Steel Bars, Forgings, Tubing and Rings, Corrosion and Heat Resistant (A-286).
AMS-H-6875 Heat Treatment of Steels.

American National Standards Institute

ANSI/ASQC Z1.4 Sampling Procedures and Tables for Inspection by Attributes.

American Society of Mechanical Engineers

ASME B46.1 Surface Texture.

American Society for Testing Materials

ASTM-E-29 Using Significant Digits on Test Data to Determine Conformance with Specifications.
ASTM-E1417 Standard Practice for Liquid Penetrant Inspection

National Aerospace Standard

NASM-1312 Fasteners, Test Methods

Hi-Shear Corporation Specifications

HS333 Installation Procedure for Hi-Set Fasteners.
HS400 Flush Head Protrusion Gauging System.

3.0 GENERAL REQUIREMENTS

Hi-Set fasteners shall conform to the requirements of Table I.



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4.0 QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. The Hi-Set fastener manufacturer is responsible for the performance of all inspections specified herein. Inspection records of the material certifications, examinations and tests shall be maintained and made available to the customer on request, for a minimum of seven (7) years from shipment of parts.

4.2 Classification of tests. The inspection of Hi-Set fasteners shall be classified as follows:

- (a) Qualification Inspection (see 4.3)
- (b) Quality Conformance Inspection (see 4.4)

4.3 Qualification Inspection

Qualification inspection shall be conducted on all characteristics specified in Table II.

4.3.1 Qualification Samples. Inspection samples for qualification shall consist of each type and diameter in sampling quantities as specified in Table II. A qualification inspection matrix is presented in Table III.

4.3.2 Certified Test Report. The Qualification inspection shall be supported by a certified test report with the actual data for the tests specified in Table II and drawings including the following additional details: dimensions, tolerances, composition of material, coating or plating applied, and heat treatment.

4.4 Quality Conformance Inspection

Quality conformance inspection pertains specifically to production lots, and shall be conducted on every production lot of Hi-Set fasteners represented in a shipment. The inspection shall consist of the examinations and tests specified in Table II.

4.4.1 Inspection Lot. An inspection lot is a production lot which is a defined quantity of finished fasteners, or components of identical configuration, fabricated from the same heat or melt of material, produced as one continuous run or order or part thereof, and presented for inspection at the same time.

4.4.2 Sampling for Examination of Product. A sample consists of one or more units of product drawn from a lot, the units of the sample being selected at random without regard to their quality. The number of units in the sample is the sample size. Selection of the sample size for inspection shall be in accordance with ANSI/ASQC Z1.4.

4.4.3 Screening. Screening (100% inspection accompanied by rejection of defective parts) may be applied to any lot which is not acceptable according to the sampling plans described herein. Screening may be applied only to characteristics inspected by non-destructive tests. For characteristics inspected by destructive tests, the entire lot shall be accepted or rejected according to test results of the prescribed sample.

4.4.4 Production Lot Inspection Report. Each production lot of fasteners shall have an inspection report on file. The report shall identify the part number and the production lot number and shall include all actual test results or certification of conformance as required by the applicable test method.

5.0 TEST METHODS

Test methods are designated in the "Inspection Requirements" column of Table I.



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**TABLE I
 GENERAL REQUIREMENTS**

Characteristics	Engineering Requirements	Inspection Requirements
Material	A-286 High temperature corrosion resistant steel.	Material chemistry shall conform to AMS5731.
Heat Treatment	Heat treatment shall be as defined herein and on the standard drawing, and includes cold reduction and artificial aging techniques. Final condition shall provide 95,000 psi shear minimum. Heat treatment and mechanical working shall develop shear properties without adverse effects on metallurgical properties, as defined herein.	Tests of mechanical and metallurgical properties verify heat treatment.
Finish	As specified on applicable standard drawing.	Visual
Lubrication	As specified on applicable standard drawing.	Visual examination and insertion testing
Mechanical Performance	Mechanical Performance of the Hi-Set Fastener shall meet the engineering requirements for Qualification and Quality Assurance Inspection as specified in Tables II and VI.	Table II
Metallurgical Characteristics	Metallurgical characteristics of Hi-Set Fasteners shall meet the requirements for Qualification and Quality Assurance Inspection as specified in Tables II and IX.	Table II
Dimensional Control	Configuration and geometry shall conform to applicable Hi-Set Fastener standard drawing and additional dimensional requirements of Table IV.	Table IV
Packaging	Fasteners shall be packaged in such a manner that they will not be damaged or exposed to undue weathering or harmful materials. A unit package may include fasteners of only one type, size, part number, and lot number. Boxes shall conform to specifications PPP-B-566, Style II or PPP-B-665, Style C. Unit packages of fasteners may be consolidated into larger packages for shipment. Packages for shipment must allow economical transportation and must conform to consolidated freight classification rules.	Visual
Marking	Each unit container shall be durably and legibly marked with the following information: brief descriptive title, part number, manufacturer's name or trademark, lot number, purchase order number, quantity in container, patent number per MIL-STD-129 and TSO number.	Visual
Installation	The fasteners covered by this specification shall be installed with tools recommended by Hi-Shear Corporation and in accordance with Hi-Shear Specification 333.	

**TABLE II
 QUALITY VERIFICATION**

Test	Test Method and Acceptance Criteria	Qualification Sampling		Quality Conformance Inspection Sampling
		Sample Size	Number of Defectives Allowed	
Dimensional Examination (except surface texture)	Table IV	24 (a)	1	Table IV
Surface Texture	Table IV	7	0	Table IV
Mechanical Properties: Tensile and Shear Strength Drivability	Table VI	7 5	0 0	Table VIII
Metallurgical Examination	Table IX	5	0	Table IX

NOTES: (a) All qualification samples tested must be dimensionally inspected. See Table III for qualification inspection matrix.
 (b) Qualification of flush or crown head shall constitute qualification of the corresponding protruding head.



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**TABLE III
 RECOMMENDED QUALIFICATION INSPECTION MATRIX**

Sample Part Number:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Dimensional Inspection	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Surface Texture	X	X	X	X	X	X	X																	
Tension Test (a)	X	X	X	X	X	X	X																	
Double Shear Test (a)								X	X	X	X	X	X	X										
Drivability: Insertion Test (a)															X	X	X	X	X					
Drivability: Upset Test (b)															X	X	X	X	X					
Metallurgical Characteristics																				X	X	X	X	X

NOTES: (a) Tension, Double Shear and Insertion Testing only when required per Table VI.
 (b) Use of separate samples for Insertion and Upset Testing is allowed, providing all samples are dimensionally inspected.

**TABLE IV
 CLASSIFICATION OF DIMENSIONAL CHARACTERISTICS
 SAMPLING AND ACCEPTANCE AT RANDOM PER ANSI/ASQC Z1.4
 General Inspection Level II**

Dimensional Characteristics	Requirements	Inspection Method	Sampling Plan
Head Height for Flush Heads Fasteners	Measurement of protrusion per Standard Drawing requirements verifies head height and theoretical (sharp) head diameter.	Dimensional Measurement per HS400 protrusion gaging system.	0.65% AQL
Diameter (Shank)	Per Standard Drawing	Dimensional Measurement	1.5% AQL
Radius (Head to shank Fillet)	Per Standard Drawing	Comparator Measurement	
Head Concentricity	Per Standard Drawing	V-Block and indicator	
Straightness of Shank	Per Table V	Surface plate and indicator	
Bearing Surface Squareness of Protruding Head	Bearing surface shall be perpendicular to shank within plus or minus one degree	Dimensional Measurement	
Head angle (flush head)	Per Standard Drawing	Comparator Measurement	
Surface Texture	Per Standard Drawing	ASME B46.1 by Visual or Fingernail Comparison	
Identification	Per Standard Drawing	Visual inspection	2.5% AQL
Length	Per Standard Drawing	Dimensional Measurement	
Head Diameter	Per Standard Drawing	Dimensional Measurement	
Head Height (Protruding Heads)	Per Standard Drawing	Dimensional Measurement	

NOTES: For purposes of determining conformance to this specification, all dimensional values shall be rounded to the nearest unit in the last right hand digit used in expressing the drawing limit in accordance with the rounding method of ASTM-E29.

**TABLE V
 STRAIGHTNESS OF SHANK**

First Dash Number	Nominal Diameter	Within Values FIR per Inch of Length
-5 and -6	5/32 & 3/16	.0040
-8 and -10	1/4 & 5/16	.0030
-12	3/8	.0025



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**TABLE VI
 MECHANICAL PROPERTIES – TEST METHODS**

Type	Test Method	Acceptance Criteria
Shear Strength	Note (a)	Note (c)
Tensile Strength	Note (b)	Note (c)
Drivability	Note (d)	Note (d)

NOTES:

- (a) Shear tests shall be performed per NASM-1312-13 except as noted. Fasteners subjected to shear tests may be installed in a double shear test fixture meeting the requirements NASM-1312-13, except blade edges shall be sharp (0.000" - 0.005"). The bearing surface of the head and fillet radius shall not contact the shear fixture. Loading rates shall not exceed 100,000 lbs per minute. This test is not applicable on production lots of fasteners having a grip less than two and one half times the nominal diameter (2.5D).
- (b) Tensile tests shall be conducted per NASM-1312-8 except as noted. Fasteners subjected to tensile testing shall be installed in maximum grip condition (+0.000", -0.010") in tension fixtures meeting the requirements of Figure 1. When testing countersunk head fasteners, an alternate tension cup must be used which provides a countersunk seat for the fastener head. Loading rates shall not exceed 100,000 lbs per minute. This test is only applicable for Hi-Set Fasteners with minimum tensile strength requirements on the corresponding standard page, with grip lengths of at least two times the nominal diameter (2D). The inspection record shall contain the actual values for the tensile tests and shall record the location on the fasteners where the break occurred for each test specimen.
- (c) Acceptance of shear and tensile tests require that all test values equal or exceed the values per the applicable drawing. Acceptance for Qualification shall additionally require that:

$\bar{X} - 1.45 (S) \geq M$, where

- M = Minimum tensile or shear value per drawing
- X = Individual value in sample
- \bar{X} = Average of X values
- $\sum X^2$ = Sum of squares of X values
- $(\sum X)^2$ = Square of the sum of X values
- N = Number of parts in the sample (7 for qualification)
- S = Best estimate of standard deviation = $\sqrt{\frac{N \sum X^2 - (\sum X)^2}{N(N-1)}}$
- 1.45 = K factor for qualification sample size of seven (7) specimens
- \geq = means "equal to or greater than"
- $\sqrt{\quad}$ = means "Square root of"

- (d) The Drivability test shall be performed on samples from the same lot, and shall include an insertion test, and an upset test. Fasteners used for the insertion test may also be used for the upset test (for grips greater than 1/2").
 - (d1) The insertion test is used to verify sufficient lubrication for interference fit applications. This test shall only be applicable to fasteners coated with Hi-Kote 1 and cetyl alcohol lube, having a grip at least two times the nominal diameter (2D). The insertion test shall be conducted per Table VII and it's notes.
 - (d2) The upset test is used to verify proper forming of the upset end. This test shall be conducted by installing the fasteners in minimum grip (± 0.05) per HS333 requirements, and is applicable to all fasteners, regardless of grip length and finish. Opening of a seam or crack, or failure to upset correctly shall be cause for rejection. Surface irregularities, stretch marks, or "orange peel" effects detected after driving shall not be cause for rejection.
- (e) For purposes of determining conformance to this specification, all specified mechanical property limits are absolute limits in accordance with ASTM-E29.



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**TABLE VII
 INSERTION TEST REQUIREMENTS**

First Dash Number	Fastener Diameter after finish (inch)		Hole Diameter (inch) (a)		Insertion Load Limits (lbs)	
					Maximum Average	Maximum Individual
-5	.1634	.1645	.1600	.1610	1500	2300
-6	.1894	.1905	.1853	.1863	1800	2400
-8	.2494	.2505	.2453	.2463	1900	2400
-10	.3119	.3130	.3078	.3088	1900	2400
-12	.3744	.3755	.3703	.3713	2100	2600

NOTES:

- (a) Specimens shall be machined from 0.500 ± 0.025 inch thick 2024-T351 aluminum alloy plate. Hole surface roughness shall be 32 microinch Ra, or smoother. Entrance edges of holes shall be chamfered or radiused .020 to .040 larger than the maximum hole diameter. Exit edges of holes may be deburred .010 maximum. Hole spacing shall be 4D (hole diameter) minimum and edge margin shall be 2D minimum. Hole and chamfer surfaces shall be solvent cleaned and dried prior to running insertion tests.
- (b) Press fastener into interference fit hole using a test machine set at 5000 lb/min maximum load rate, or at a crosshead speed of 2.00 ± 0.25 inch/min. Referee testing shall be conducted at a crosshead speed of 2.00 ± 0.25 inch/min. Insertion load is the highest load recorded prior to seating of the fastener head. High loads attributed to seating of the head-to shank radius do not apply.
- (c) Individual insertion loads shall not exceed Maximum Individual limit, nor exhibit a lot average in excess of the Maximum Average limit specified above.

**TABLE VIII
 QUALITY ASSURANCE INSPECTION SAMPLING FOR
 MECHANICAL AND METALLURGICAL PROPERTIES**

Lot Size	Sample Size	Acceptance No.	Rejection No.
Under 500	2	0	1
501 to 2,500	4	0	1
2,501 to 10,000	5	0	1
10,001 to 50,000	7	0	1
50,001 to 100,000	10	0	1
100,001 and over	15	1	2

NOTES: Acceptance and Rejection numbers for Metallurgical test only. For Mechanical properties, each part tested must meet the acceptance requirements.



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**TABLE IX
 METALLURGICAL CHARACTERISTICS**

Metallurgical Characteristics	Requirements	Test Method	Quality Conformance Inspection Sampling	Acceptance Criteria
Discontinuities (a)	Fasteners shall be free from cracks in any location. (b) Other discontinuities (laps, seams, nicks and gouges) are permitted only in locations and quantities specified in Table X. (c)	Penetrant inspect (post emulsification) per ASTM E1417 Type I Methods B or D except that penetration time shall not be less than 30 minutes and stamping of individual parts is not required. Micro examination at 50X to 100X (d)	Penetrant inspect per ANSI/ASQ Z1.4, 0.040% AQL. Micro examination per Table VIII.	Table X.
Microstructure	Microstructure shall be uniform with grain size/shape variance permitted in worked areas (head to shank fillet, etc.). Microstructure shall show no evidence of surface or sub-surface inclusions at the head-to-shank fillet. Small inclusions in other parts of the fastener are not indicative of unsatisfactory quality and shall not be cause for rejection. Microstructure shall be free from imperfections detrimental to the functionality of the part (bursts, voids, etc.).	Micro examination at 100X or greater.	Table VIII.	Table X.
Grain Flow	Heads shall be formed by upset forging method. A longitudinal section through the head shall show no detrimental defects. The grain flow lines may be slightly broken by finish machining or grinding. (See Figure 2).	Micro examination at 10X or greater.	Table VIII.	Figure 2.

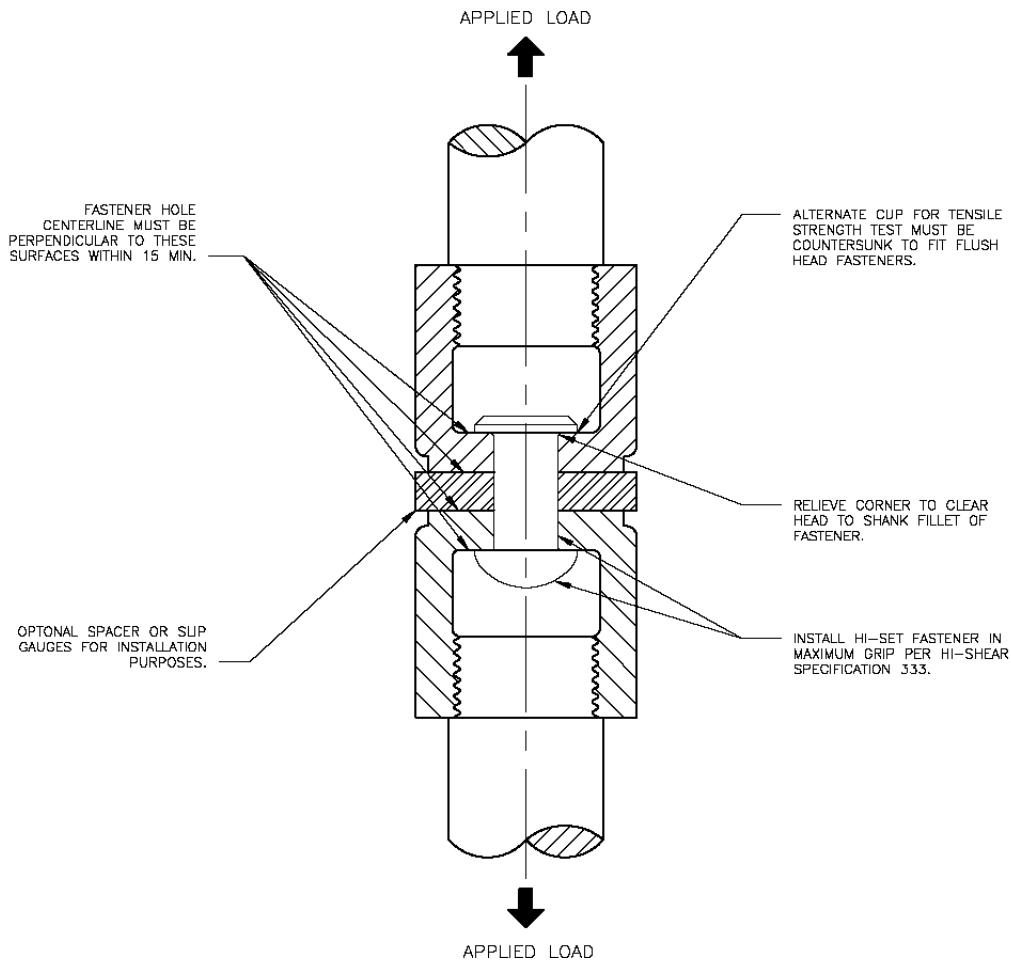
NOTES:

- (a) Any discontinuity that is not a crack, regardless of location, with a depth of 0.0005 inch or less, is considered a non-ratable discontinuity and shall not be cause for rejection.
- (b) Care must be exercised to avoid confusing cracks with other discontinuities. A crack is defined as a clear crystalline break passing through grain or grain boundary without inclusion of foreign elements.
- (c) A lap is a surface defect caused by folding over metal fins or sharp corners and then rolling or forging them into the surface. A seam is a lap that has been closed but not welded.
- (d) For inspection of discontinuities: With no penetrant indications present, micro examine a random sample per Table VIII for acceptance or rejection of entire lot. If penetrant indications are present, micro examine at the indication to determine whether penetrant indications reveal discontinuities exceeding limits specified in Table X. If one or more unacceptable discontinuities are found, the entire lot be rejected. 100% inspection screening may be used to reject all parts with similar penetrant indications.
- (e) Fasteners used for metallurgical examination of discontinuities may be used for all or part of the sample for examination of other metallurgical characteristics.

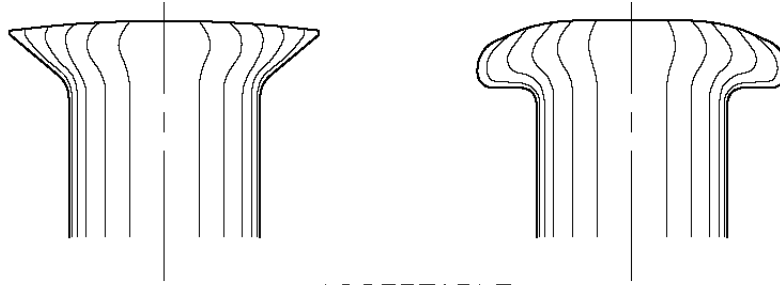
**TABLE X
DISCONTINUITIES – LIMITS**

Location	Permissible Discontinuities	Maximum Depth Normal to Surface (Inches)	
		Nominal Size or Diameter of Fastener	
		5/32, 3/16, 1/4 & 5/16	3/8
Head-to-Shank Fillet	None	.000	.000
Grip or Shank Diameter	Seams – Not extending into head-to-shank fillet.	.005	.006
Non-Bearing Surfaces of Head	No more than three total Laps, seams, nicks or gouges.	.010	.012

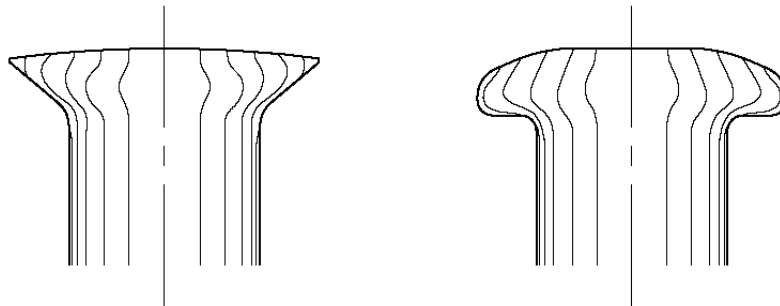
NOTES: For purposes of determining conformance to this specification, all specified limits are absolute limits in accordance with ASTM-E29.



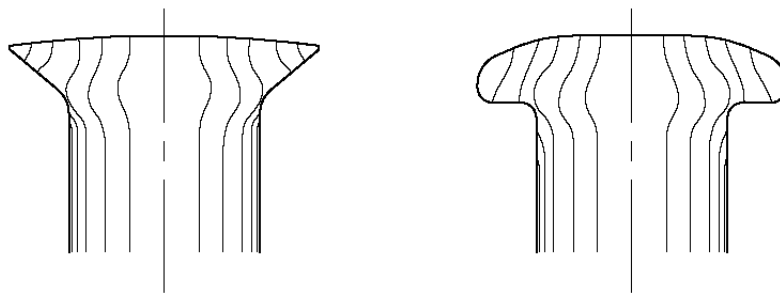
**FIGURE 1
TENSION TEST**



ACCEPTABLE



MINIMUM ACCEPTABLE
GRAIN FLOW LINES SLIGHTLY BROKEN
BY THE FINISH MACHINING OR GRINDING



UNACCEPTABLE
EXCESSIVE CUTTING OF GRAIN FLOW LINES IN THE SHANK,
HEAD -TO-SHANK FILLET, AND BEARING SURFACE.

FIGURE 2
GRAIN FLOW