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COMPLIANCE IS MANDATORY

John C. Stennis Space Center MACHINE SHOP TOLERANCES

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Document History Log

Change/ Revision	Change Date	Originator/ Phone	Description
Basic	02.24.2012	B. Farner/2967	Initial release, supersedes SSC 66-505.
A	04.05.2017	B. Farner/2967	Five-year update. Revised cover sheet to reflect approval by CO OMD, and concurrence by PMD. Updated references and acronyms. Administrative changes required. Added section 5.5-b. Section 6.1, revised Figure 2/Table 2. Section 13.5 was deleted, as it was a duplicate of information included in Section 6.1-b. Section 13.7, Welded Aluminum Corners, was deleted. Section 17.1, inserted the word “burrs”. Section 20.6: Clarified that the Tolerance “Y” reference in Figure 52 is in inches.
B	01.31.2022	David Failla 8-2228	Five-year review. Updated titles of Responsible Organizations, references and acronyms.

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1.0 PURPOSE

This John C. Stennis Space Center (SSC) standard (SSTD) specifies the shop tolerances for the use of the designer or for shop use when no tolerances are specified on a drawing.

2.0 APPLICABILITY

- a. Tolerances specified on a drawing shall have precedence over tolerances in this SSTD.
- b. For unspecified tolerances, the shop supervisor shall be responsible for using tolerances in compliance with this SSTD.

3.0 REFERENCES

All references are assumed to be the latest version unless otherwise indicated.

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

ANSI/ASME Y14.5, *Dimensioning and Tolerancing*

ASME B1.20.1, *Pipe Threads, General Purpose, Inch*

FED-STD-H-28/2, *Screw-Thread Standards for Federal Services, Section 2, Unified Inch Screw Threads – UN and UNR Thread Forms*

SAE AS71051, *Pipe Threads, Taper, Aeronautical National Form, Symbol ANPT – Design and Inspection Standard*

SAE AS8879, *Screw Threads – UNJ Profile, Inch Controlled Radius Root with Increased Minor Diameter*

SPR 1440.1, *SSC Records Management Program Requirements*

SSTD-8070-0005-CONFIG, *SSC Preparation, Review, Approval, and Release of SSC Standards*

4.0 RESPONSIBILITIES

- a. Users of this SSTD shall comply with its requirements, ensure use of the correct version of this SSTD and the documents it references, and inform the appropriate organization of needed changes in accordance with SSTD-8070-0005-CONFIG.
- b. Responsibilities for the use and control of this SSTD and for the review and approval of revisions or cancellation of this SSTD shall be as specified in SSTD-8070-0005-CONFIG and the applicable documents referenced therein.

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5.0 GENERAL

5.1 Dimensioning and Tolerance

- Interpretation of dimensions and tolerances shall be in accordance with ANSI/ASME Y14.5 and as supplemented herein.
- Parts exceeding tolerance limits to any degree, regardless of magnitude, shall not be considered as meeting drawing requirements.
- When linear tolerances are not given, the following shall apply:

Table 1

DIMENSION	ALLOWABLE TOLERANCE
Fractional	$\pm 1/16''$
One decimal place	$\pm .030''$
Two decimal places	$\pm .020''$
Three decimal places	$\pm .010''$

5.2 Dimensions

5.2.1 Dimensions and Finishes

Measurement of dimensions and tolerances include applied metallic finishes such as electroplate, immersion plate, etc., and also include inorganic finishes such as anodic treatment, metal coloring, localizing, and chromate treatment. Measurements do not include applied organic finishes such as paints, varnishes, enamels, phosphates, etc.

5.2.2 Dimensions Reference

Dimensions marked "Reference" are not to be used for inspection purposes.

5.2.3 Dimension Reference Temperature

All dimensions are expressed in inches at the international standard reference temperature of 20°C (68°F). The manufacturer is responsible for making the necessary conversion for temperature variation.

5.2.4 Machine Setting Dimensions

Four- or five-place decimal dimensions without tolerance are used as machine setting dimensions for precise machining such as jig bore work, gear cutting, and

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for data dimensions such as gear Ditch center lines, screw Ditch diameters, and similar applications. Such dimensions are not for inspection purposes.

5.3 Tolerances, Material

When standard raw material cross-sections are specified without tolerances on the drawing, the tolerances referenced in the material specification shall apply.

5.4 Countersinks and Counterbores


Countersink or counterbore diameter shall be concentric within .005" to the hole diameter.


5.5 Threads

- a. Screw thread form shall meet the requirement of FED-STD H-28/2. All threads are right hand unless otherwise specified.
- b. SAE AS71051 applies for National Pipe Thread (NPT) type threads on fluid system tube fittings. ASME B1.20.1 applies to NPT type threads used for fluid system pipe and pipe fittings, and for structural connections. For straight thread on fluid system tube fittings, SAE AS8879 Class 3 applies unless the applicable drawing or specification states otherwise. Class 2 threads should be the standard for all straight (UN, UNR, UNJ, UNC type) thread connections that are not used on fluid system tube fittings, unless the applicable drawing or specification states otherwise.

5.6 Surface Roughness

- a. Interpretation of finish symbols such as 16/ and 63/ shall be in accordance with ANSI/ASME B46.1. The finish symbol indicates that material must be allowed for machining to the specified roughness.
- b. When a surface is produced by other methods such as casting, forging, and broaching, the finish is indicated with added notes such as follows:

 as cast

  as forged

5.7 Spot Face

A spot face is a round flat surface (usually around a clearance hole) machined on a finished or unfinished surface in a plane perpendicular to the axis of a hole through the "spot". The "spot" can be an accurate or an approximate diameter as specified.

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5.8 Welding

- a. All weld splatter shall be removed.
- b. High spots and irregularities shall be within the finish requirements specified for the weld.
- c. Contrasting surface appearance on the area adjacent to welds shall be acceptable.

5.9 Notes

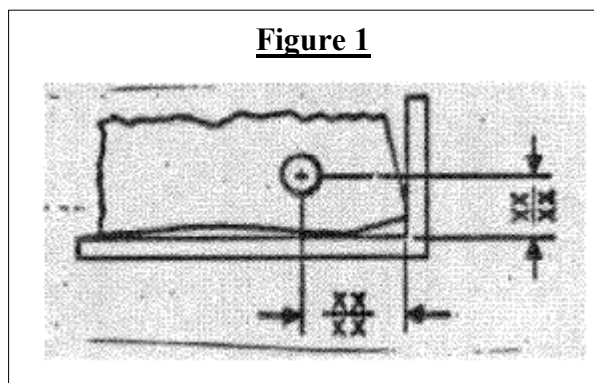
The figures in this document are used for illustration only, and may be over-detailed or incomplete.

6.0 MEASUREMENTS

6.1 Linear Dimensions

- a. Measurements

Linear dimensions locating features from an edge are measured from the extremity of the edge. (See Figure 1.)



- b. Irregularities Of Cut-offs

The cut-off on the edge of a part shall not vary from the plane shown on the drawing by more than the Tolerance "Y". Tolerance "Y" must not cause overall dimension to exceed its tolerance. (See Figure 2.)

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Figure 2

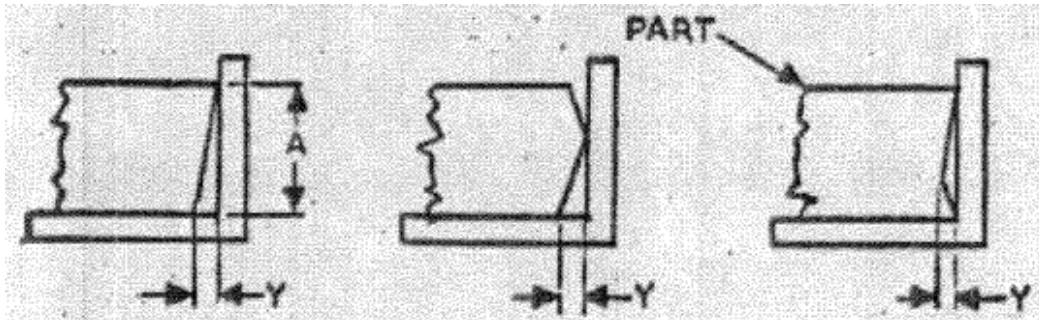


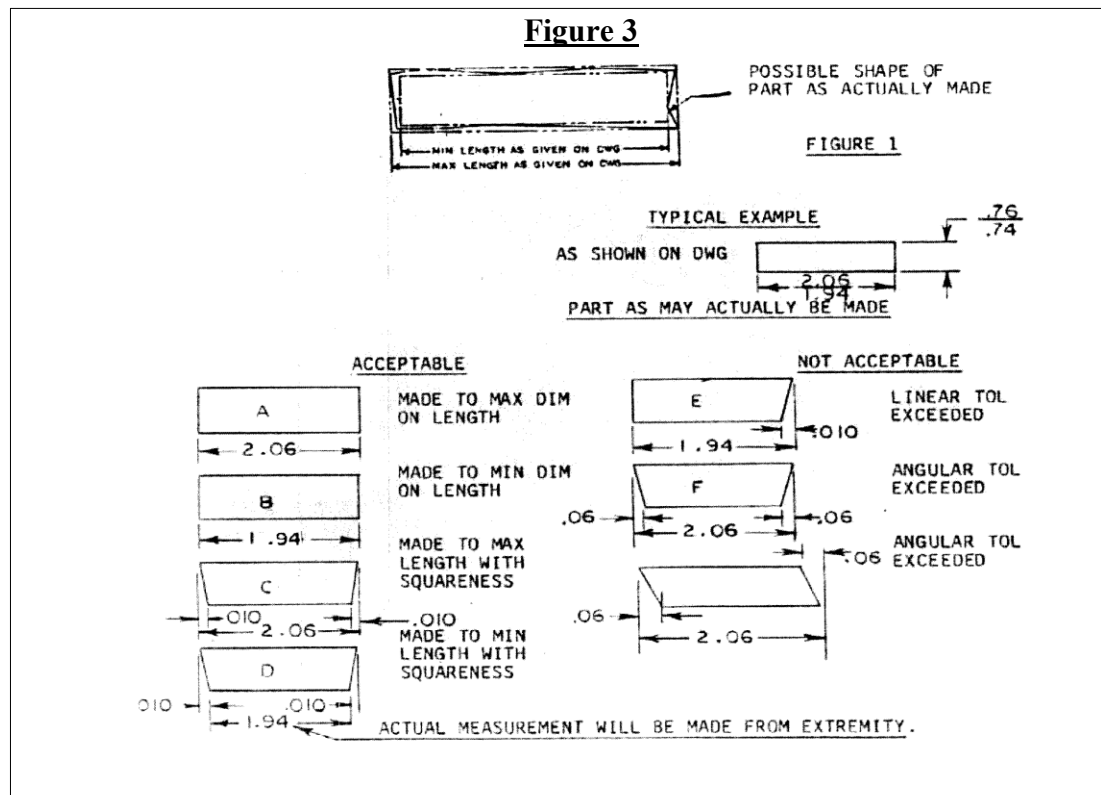
Table 2

Material Thickness Cut (Thickness is into page on Figure 2.)	Material Width Cut	
	Width Dimension A	Tolerance Y
Up to & including .125"	Up to & including 1"	.010"
	Over 1"	.010 in./in. of "A" but not to exceed .30"

6.2 Relation Of Linear Tolerance And Angularity Tolerance

Irregularities in the perimeter of the finished part will be permitted provided all points on its outer edges are within dimensional tolerances, except when restricted by the requirements of Section 6.1. (See Figure 3.)

Figure 3



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7.0 BORED HOLES, ALINGMENT, AND SQUARENESS

7.1 Tolerances

Table 3 gives the tolerances which apply to alignment, squareness, and out-of-round holes having a total diameter tolerance of .002" or less.

7.2 Total Indicator Run-out (TIR)

The total indicator run-out (TIR) of precision holes delineated in line with other precision holes, and the squareness of these holes in relation to other precision holes or machined surfaces shall be within the values shown in Table 3. (See Figure 4.)

7.3 Out Of Roundness

The out of roundness of precision holes shall not exceed the tolerance of the hole diameter. (See Figure 4.)

7.4 Alignment

The alignment of precision holes delineated in line with other precision holes shall be measured in terms of TIR.

Figure 4

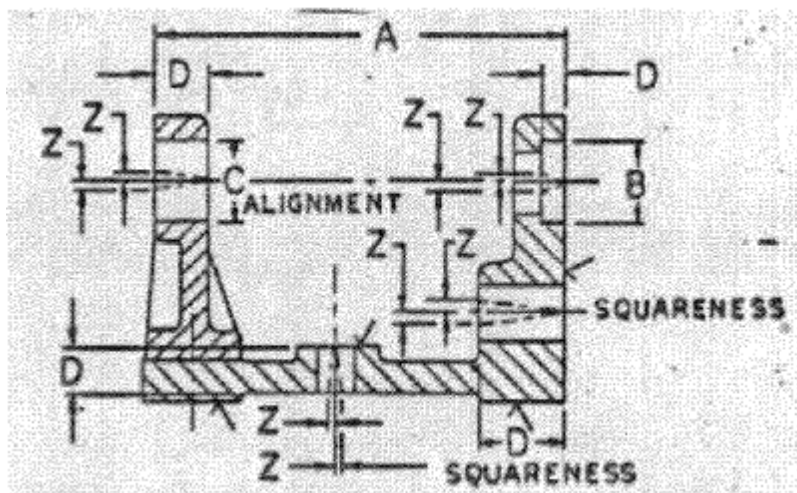


Table 3

Distance A	Between (TIR) Bores B & C	Squareness Tolerance Z for Precision Bored Holes
Up to & including 12"	.001"	For D = 1" or less For Z = .0005"
Over 12" including 18"	.002"	For D = over 1"
Over 18"	.003"	For Z = .0005" per inch of D

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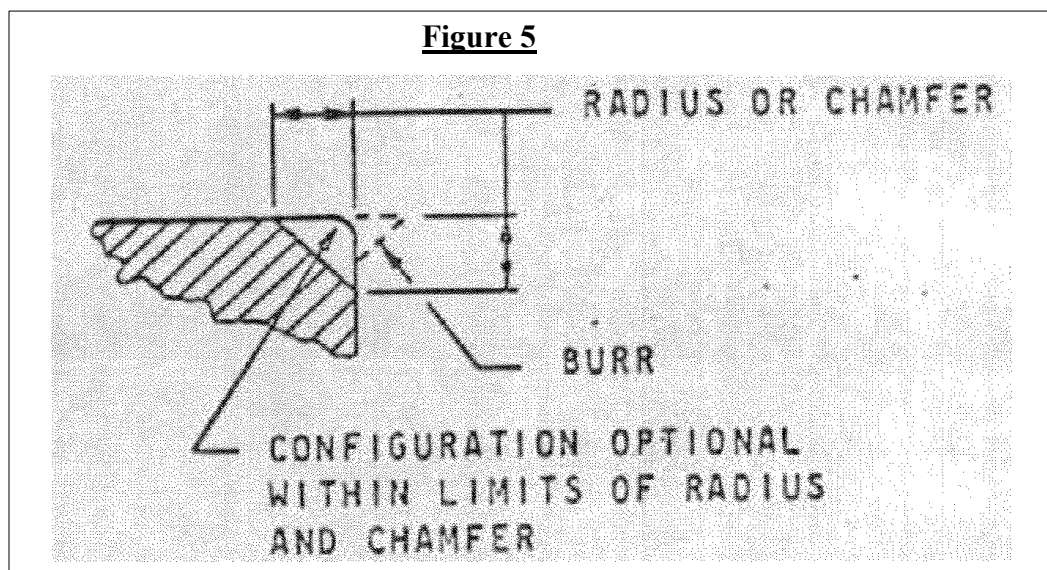
8.0 BURRS AND SHARP EDGES

8.1 Burrs

- A burr is defined as that material extending beyond either of two intersecting surfaces.
- Any burr which can be dislodged by vibration or handling, and/or is sharp, and/or exceeds the drawing limits for the final assembly part configuration, shall be removed.

8.2 Sharp Edges

- All sharp edges must be dulled or broken by any suitable process which will produce a radius or chamfer as specified below. Edges of a definite radius, when required, will be specified on the drawing. (See Figure 5.)



- When sharp corner is specified on the drawing, the radius or chamfer shall not exceed .010" max.
- When not specified 0 on the drawing but delineated sharp, the radius or chamfer shall not exceed .030" max.

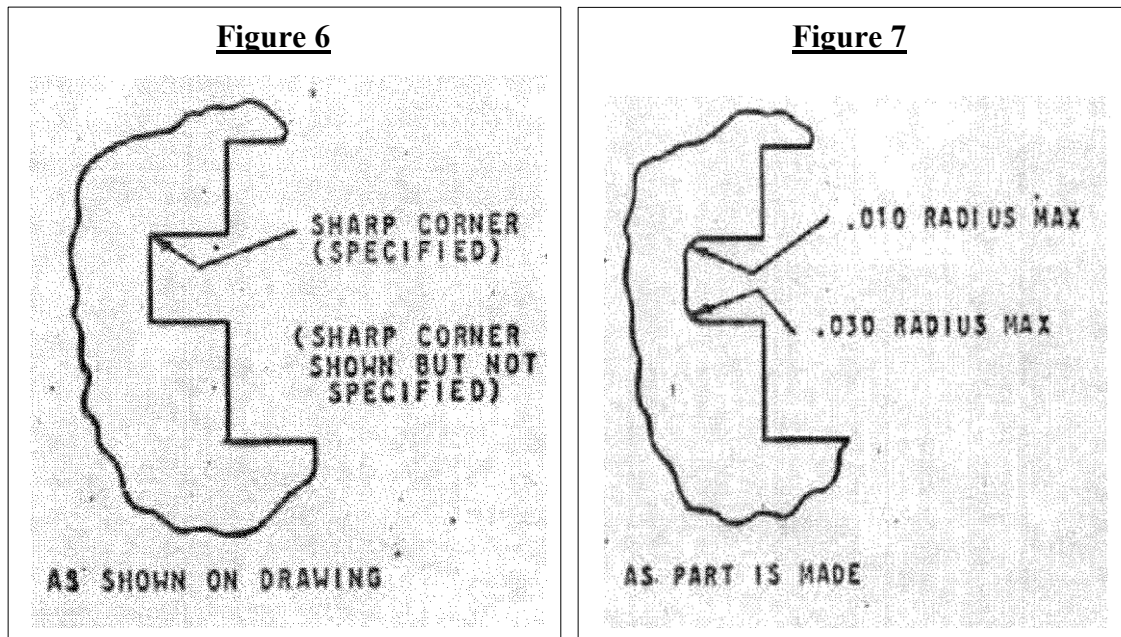
9.0 CORNERS, INTERNAL AND EXTERNAL

9.1 Internal Corners

- When internal corners are shown on a drawing but no dimension is specified (see Figure 6), the part shall be made as shown in Figure 7.

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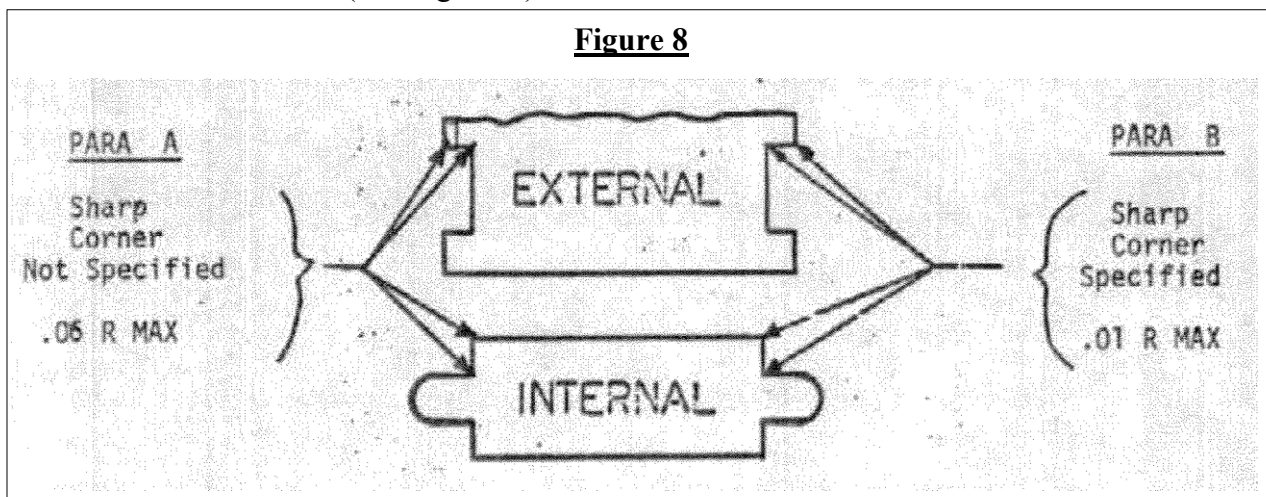
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- b. When sharp corner is specified on the drawing, the radius shall be .010" max., with undercut not permitted.
- c. When sharp corner is shown on the delineation, but not specified, the radius shall be .030" max., with undercut not permitted.

9.2 Notches And Cutouts

- a. When a sharp corner is shown but not specified on a drawing, the radius shall be .06" maximum. (See Figure 8.)
- b. When a sharp corner is specified by note or a drawing, the radius shall be .01" maximum. (See Figure 8.)



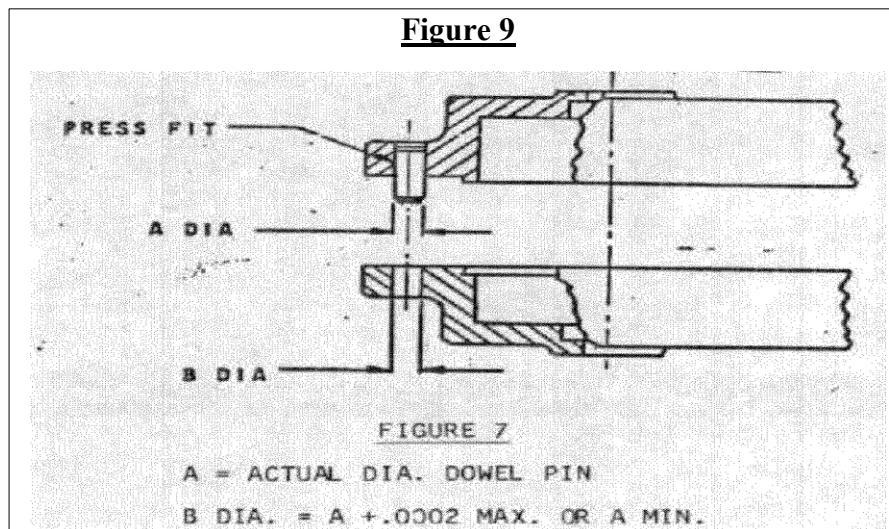
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10.0 DOWLING

10.1 Matched Parts

- a. In order to ensure accurate alignment after disassembly and reassembly, matched parts shall have a press-fit on the pin in one member and shall be from zero (line-to-line) to .0002" loose in the mating member. (See Figure 9.)



- b. The pin is usually pressed into the softer, thicker, or removable member.
- b. Matched parts include those which are machined, aligned, stocked or supplied in pairs (or mating parts) such as gear boxes, optical units, etc.

10.2 Redoweling

When it is necessary to replace a dowel pin, or pin, straight, headless due to looseness incurring in disassembling and reassembling, the size of pin used shall be as follows:

- a. Use .001" oversized, commercial dowel pin.
- b. If oversized, commercial dowel pin is not large enough to take up the looseness:
 1. In non-ferrous material, use next available size of drill rod.
 2. In ferrous materials, re-drill and ream for the next larger size commercial dowel pin.
 3. In no case shall diameter of dowel pin used be greater than the next commercial size above that specified on the drawing.
 4. In ferrous materials, if conditions will not permit next larger size dowel pin, re-ream for the next size larger drill rod.

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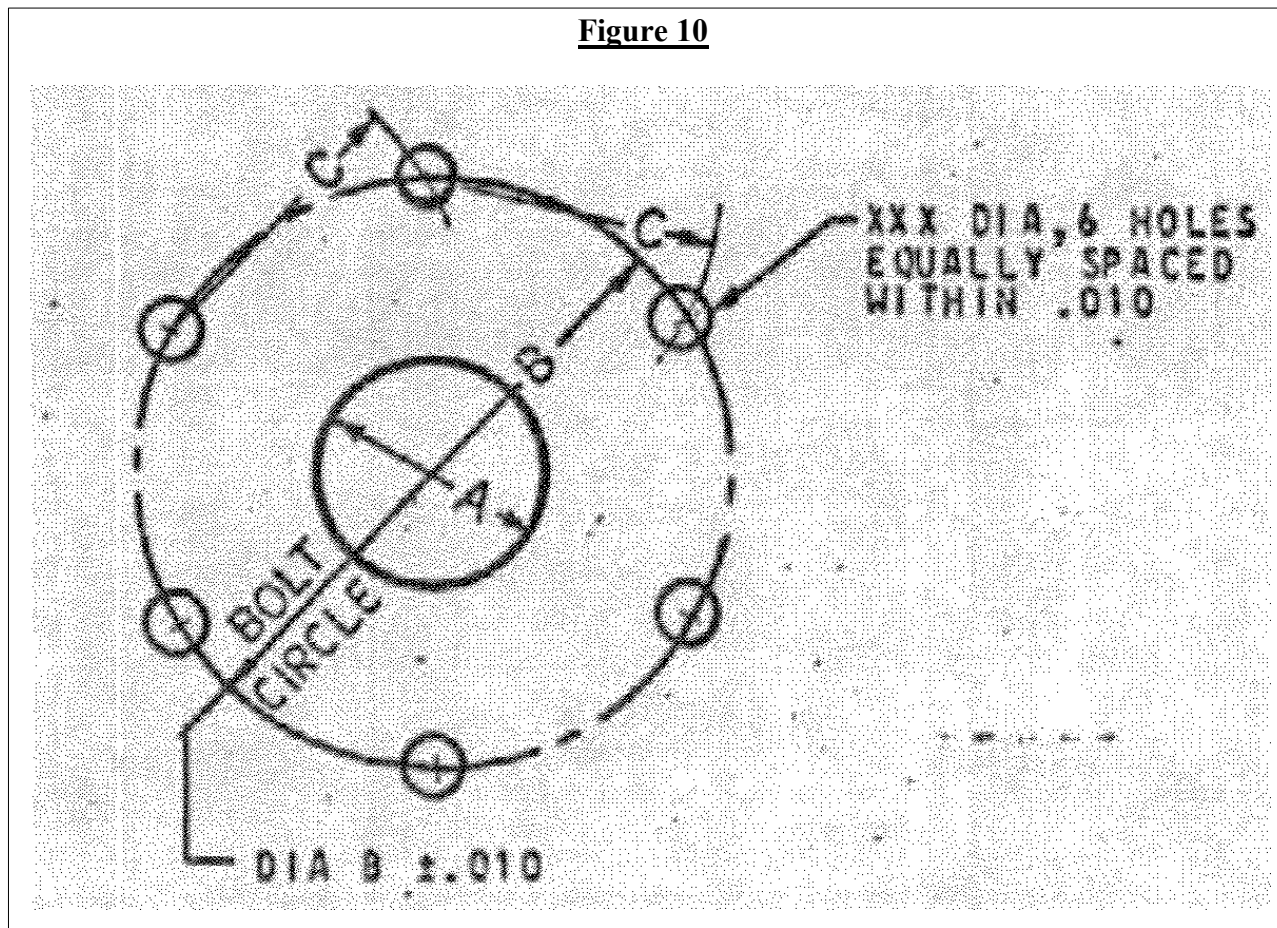
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11.0 DRILLED HOLES

11.1 Bolt Circle Hole Spacing

- a. Holes shall be equally spaced to each other within limits given on drawing (tolerances not cumulative); meaning that chords "C" between any two adjacent holes must be equal within the limits specified. (See Figure 10 for typical example.)
- b. The bolt circle shall be concentric with other cylindrical surfaces within tolerance given on bolt circle.
 1. The six holes must be equally spaced so that chords "C" are of equal length within .010".
 2. Bolt circle "B" must be concentric with diameter "A" within .020" TIR.

Figure 10



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11.2 Hole Alignment

Where two (2) or more centers on a part are located on a common plane, the center line shall not vary from the true reference plane by more than Tolerance "Y" given in Table 4. (See Figures 11 and 12. NOTE: A = distance between centers features measured.)

Figure 11

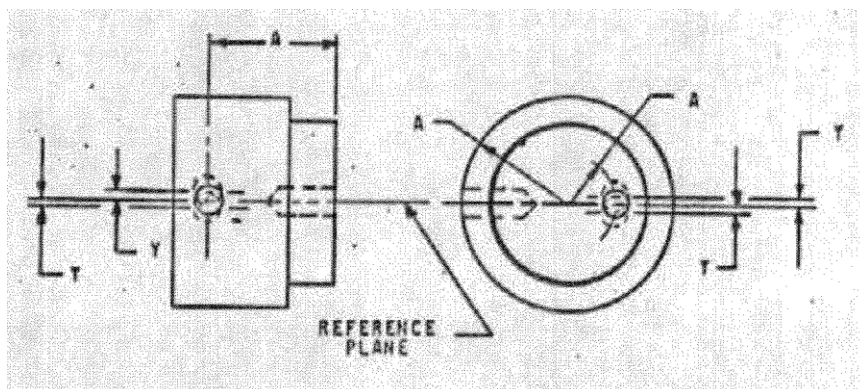


Figure 12

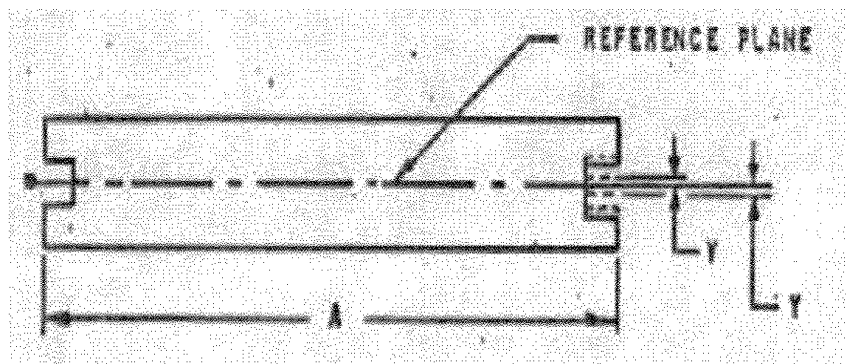


Table 4

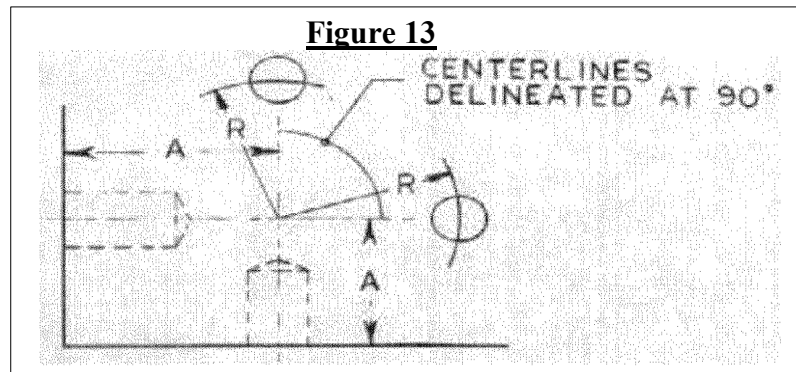
Dimension A	Tolerance Y
Up to & including 3"	.010"
Over 3" up to & including 6"	.016"
Over 6"	.020"

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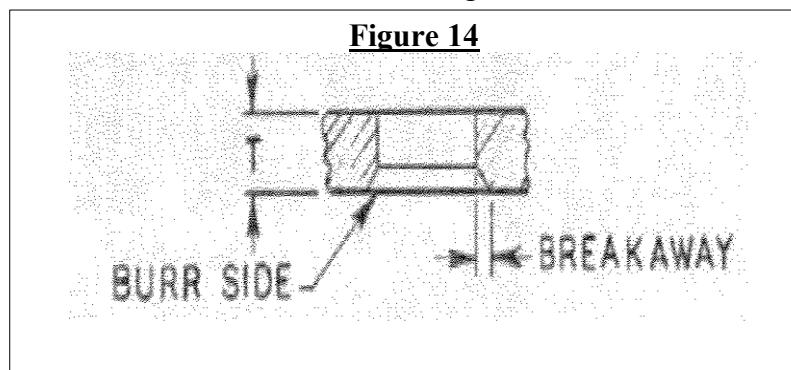
11.3 Squareness Of Hole Centerline

Center lines of drilled holes delineated at 90 degrees to each other shall be square within one degree (.016 in./in.) but not to exceed .030" at any distance "A" or "R". (See Figure 13.)



11.4 Round Holes, General

- a. Out of plumb is the variation from the true axis of the hole.
- b. The out of plumb tolerance shall not be increased by the amount of locational tolerance. The finished hole must fall within the locational tolerance for the hole
- c. The out of round tolerance must not exceed the tolerance for hole diameter.
- d. The finish (surface roughness) on drilled holes up to and including ½" diameter will be 250/ and over ½" diameter will be 500/.
- e. True position tolerancing: When features are located by means of true position tolerancing, the angularity (out-of-plumb) limits established by the true position tolerances shall take precedence over the angularity tolerance.
- f. Punched holes may have a taper (breakaway) equivalent to 10 percent of the material thickness. The hole diameter shall be within tolerance for ⅔ of the material thickness "T" as shown in Figure 14.



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11.5 Round Holes, Tolerances

Unless otherwise specified, the following tolerances in Table 5 will apply:

Table 5

Round Holes, Drilled And Punched*				
Diameter Of Hole		Variation From Basic Size		Out-Of-Plumb Tolerance Per Inch of Drill Depth
Over	To & Include	Metal**	Non-Metal***	
---	.040"	+0.002" -0.001"	+0.001" -0.003"	.015"*****
.040"	.070"	+0.003" -0.001"	+0.001" -0.003"	.015"*****
.070"	.128"	+0.004" -0.001"	+0.001" -0.004"	.010"*****
.128"	.228"	+0.005" -0.002"	+0.002" -0.005"	.008"
.228"	.500"	+0.006" -0.002"	+0.003" -0.007"	.006"
.500"	.750"	+0.008" -0.002"	+0.003" -0.008"	.005"
.750"	1.00"	+0.010" -0.003"	+0.005" -0.010"	.005"
1.00"	3.00"	+0.015" -0.010"	+0.005" -0.015"	.005"
3.00"	6.00"	+0.020" -0.010"	+0.007" -0.020"	.005"
6.00"	---	+0.030" -0.010"	+0.010" -0.030"	.005"
<p>*All dimensions in inches.</p> <p>**This includes all metals, Mycalex, or similar stable materials.</p> <p>***This applies to all non-metallic materials having shrinkable characteristics.</p> <p>****Applies up to ½" deep; beyond ½" deep tolerance will be specified on drawing.</p>				

12.0 FINISHES

Finishes and surface roughness are generally covered in Section 5.6. For detailed requirements and definitions, use ANSI/ASME B46.1. For hole finishes, see Section 11.4.d.

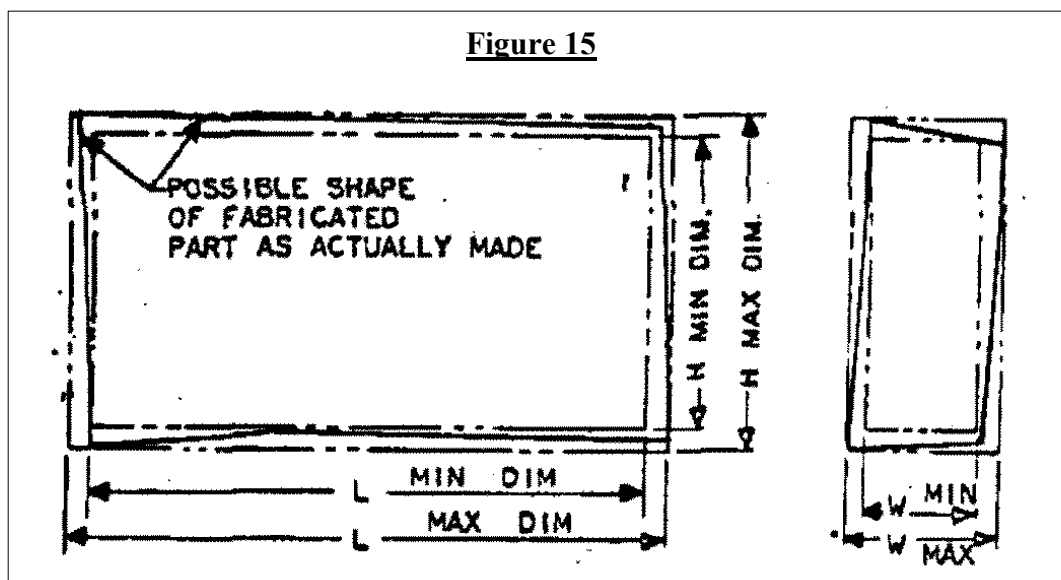
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13.0 FORMED PARTS

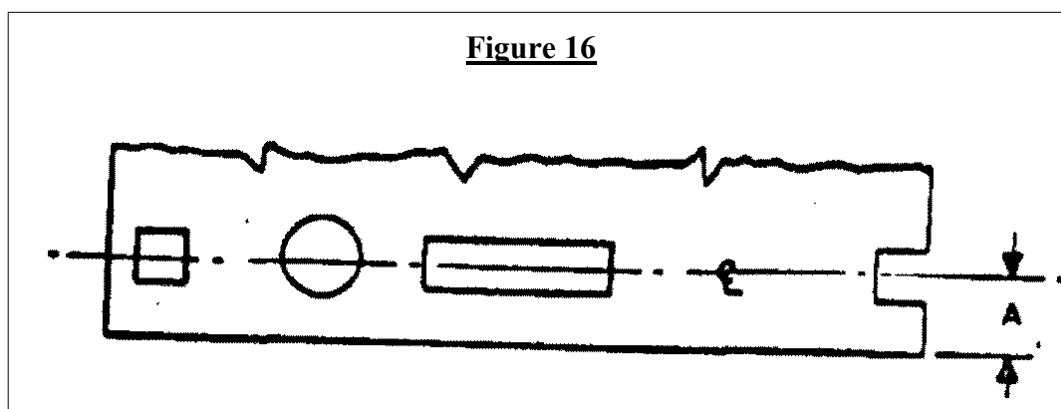
13.1 Angularity Of Frames

The actual shape of a fabricated part, welded, brazed, soldered, riveted, or fastened by other means may be irregular provided all points on its outer edges come within the dimensional tolerances. (See Figure 15.)



13.2 Alignment Of Holes And Slots

Where two or more holes, slots, or other features are delineated on a common centerline, they shall be in line within $\frac{1}{2}$ " the tolerance given on the locating dimension "A" (see Figure 16), but not less than $\pm.01$ ".



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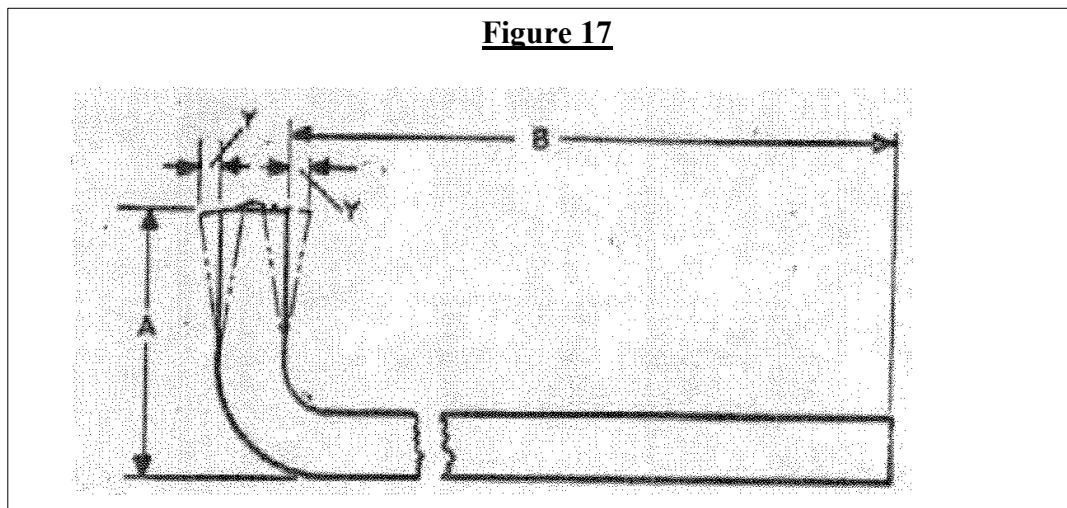
13.3 Bending And Forming

The following bending requirements apply to plates, bars, rods, pipes, tubes, and structural shapes.

13.3.1 Tolerance

The Tolerance "Y" will be .03" per inch of dimension "A", but must not exceed the tolerance for dimension "B". ("A" is less than or equal to "B". See Figure 17.)

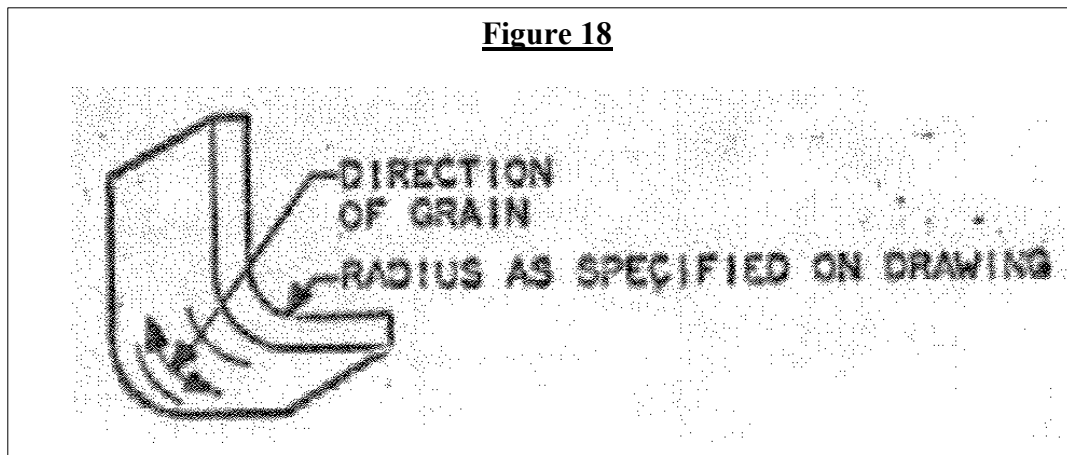
Figure 17



13.3.2 Bending And Forming RADII

All bends should, if possible, be made across the grain $\pm 45^\circ$. (See Figure 18.)

Figure 18



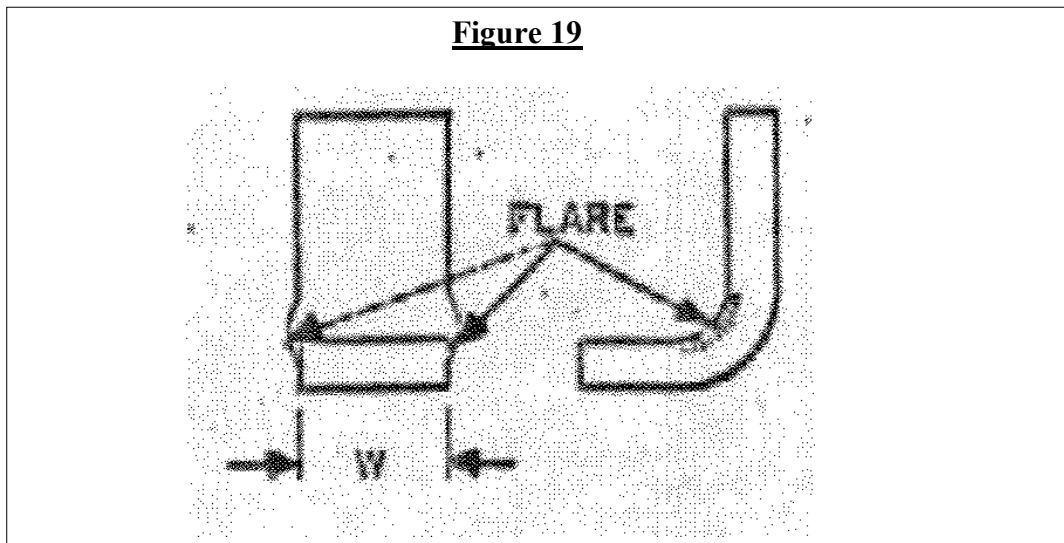
13.3.3 Flare Due To Bending

The flare produced by bending will be acceptable provided the flare is within tolerances for width "W". (See Figure 19.)

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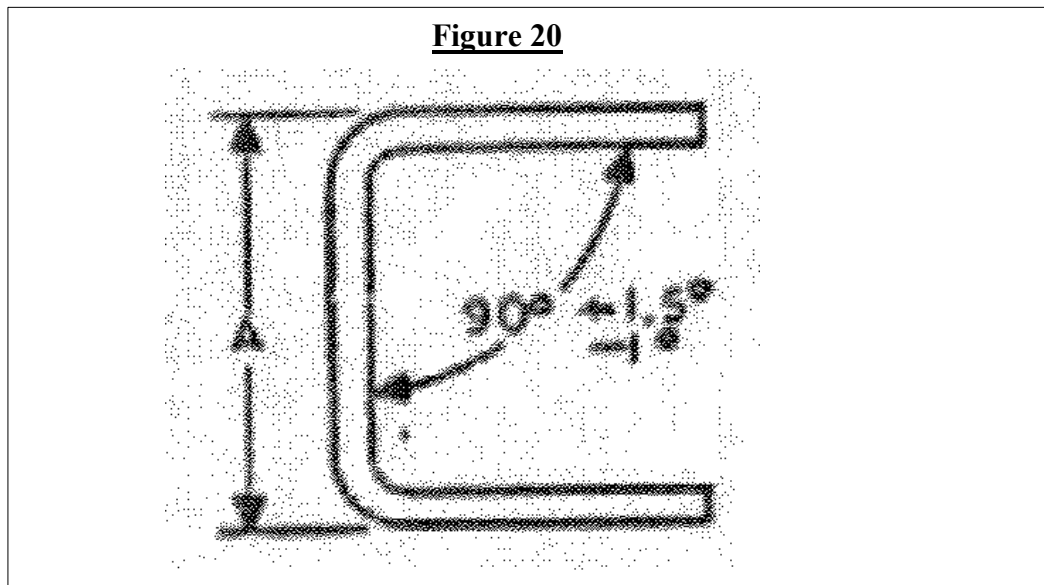
Figure 19



13.3.4 Squareness of 90° Bends

The squareness of bends delineated at 90° will be within tolerance given in Figure 20 for any thickness of metal. This angularity tolerance must not cause the tolerance on the linear dimension “A” to be exceeded.

Figure 20



13.4 Cut Surfaces

The following requirements apply to plate, bars, rods, pipes, tubes, and structural shapes.

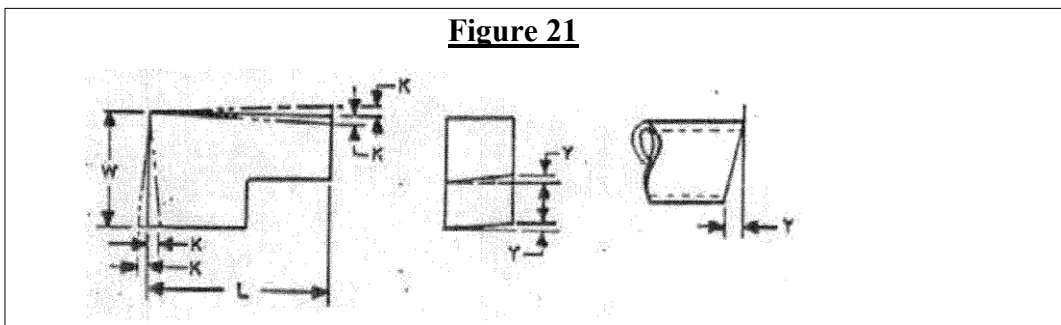
- Dimensions shall be measured from the extremity of an edge.
- The angularity Tolerance “K” shall not exceed the tolerance for dimensions “L” and “W”.

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- c. The squareness Tolerance “Y” of a cut shall not exceed .03” for material up to and including .50” thick or diameter and .06” per inch of thickness or diameter for material over .50”. (See Figure 21.)

Figure 21



13.5 Surface Flatness Of Formed Parts

The amount that a flat surface may warp or bulge from a true plane shall be within the values given in Figure 22.

Figure 22

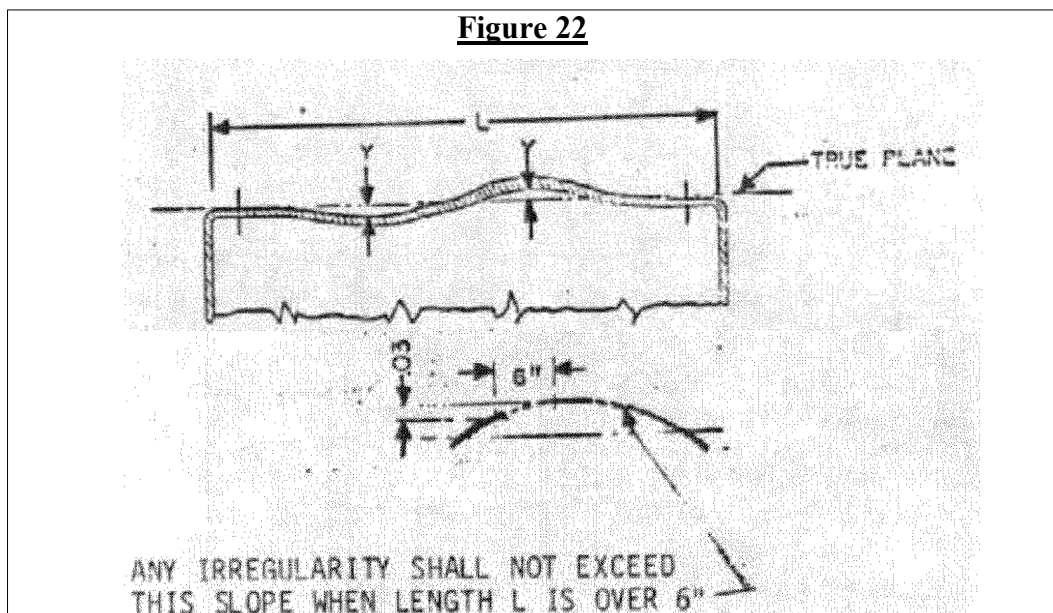


Table 6

Distance L	Tolerance Y
Up to & including 6"	.015"
Over 6" up to & including 12"	.03"
Over 12" up to & including 24"	.09"
Over 24" up to & including 72"	.12"

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13.6 Twist On Formed Parts

The tolerance on the twist will be in accordance with values given in Figure 23.

Figure 23

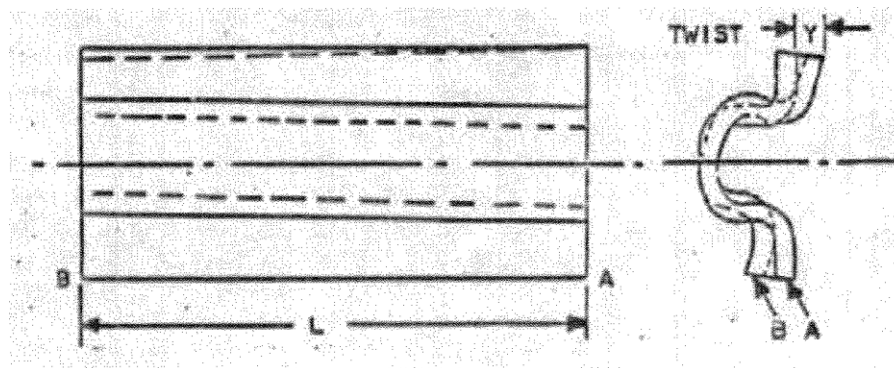


Table 7

Thickness of Material	Length L	Tolerance for Twist Y
Up and including .125"	Up to & including 1"	+.015"
	Over 1"	+.030"

14.0 KEYWAYS

14.1 Radial Position Of Keyways

Keyways, spline teeth, setscrews, gear teeth, and taper pins, unless otherwise specified on the drawing, may be located radially at random even though they may be delineated in line with other keyways, holes, etc. when the drawing specifies that keyways must be in line the tolerance in Table 8 applies. (See Figure 24.)

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Figure 24

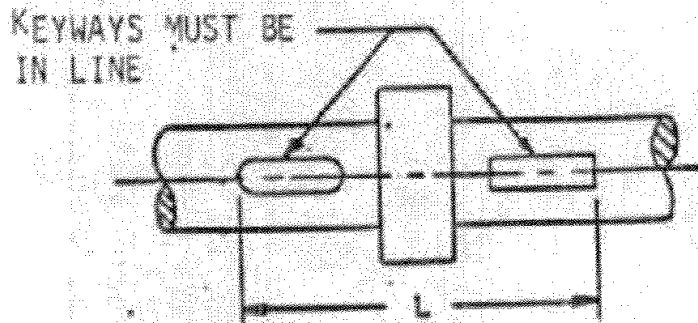


Table 8

Distance L	Keyway Alignment Tolerance
Up to and including 6"	.001"
Over 6" to and including 12"	.0015"
Over 12"	.002"

14.2 Alignment Of Keyways

The centerline of a keyway in a shaft or bore shall be centered within Tolerance "Y" as shown in Figures 25 and 26. (See Table 9.)

Figure 25

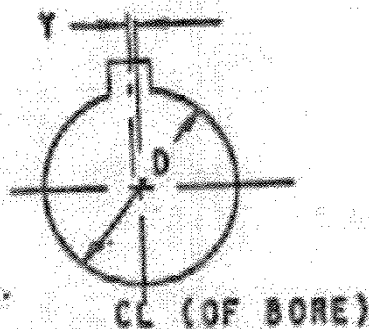


Figure 26

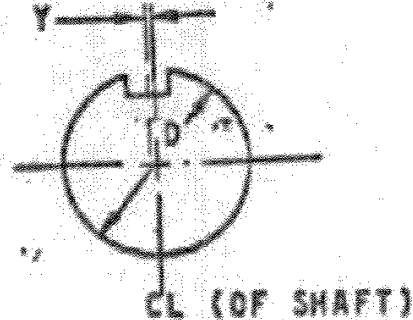


Table 9

Diameter D	Tolerance Y
Up to and including .500"	.002"
Over .500" to and including 4"	.002"
Over 4"	.003"

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15.0 PUNCHED HOLES

15.1 Concentricity of Washer Type Punchings

The center of a round hole shall be on the center of a round blank within the tolerance specified in Figure 27.

Figure 27

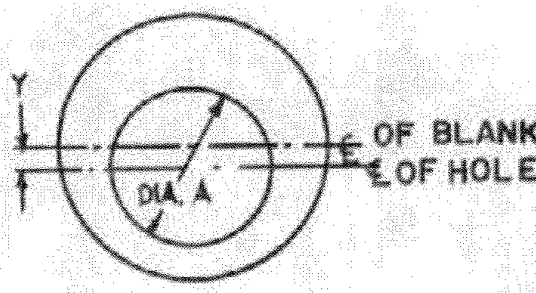


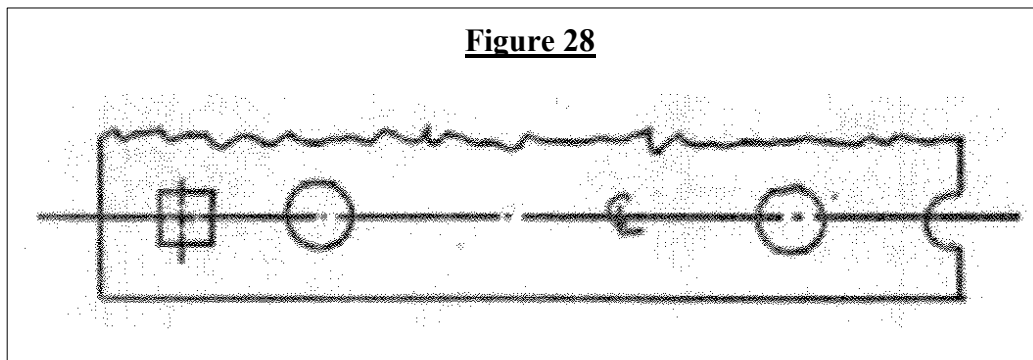
Table 10

Diameter A	Tolerance Y
Up to and including 3"	.02"
Over 3"	.04"

15.2 Alignment of Holes, Slots, Etc.

Where two or more holes, slots, etc. are delineated on a common centerline, they shall be in line within .010" of the center line. (See Figure 28.)

Figure 28



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16.0 SURFACES

16.1 Formed Parts Surfaces

Refer to Section 13.6, Surface Flatness of Formed Parts.

16.2 Machined Parts

16.2.1 Flatness of Machined Surfaces

Flatness of a machined surface shall be within the values given in the following table except that in no case shall “Y” exceed dimensional tolerances. (See Figure 29.)

Figure 29

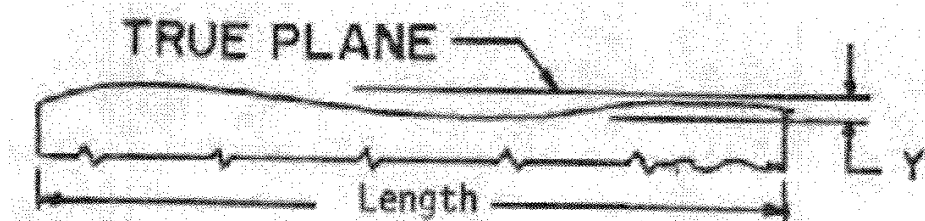


Table 11

Surface Roughness	Tolerance Y
Up and including 32 ✓	.001" up to and including 6" length .002" above 6" to and including 12" length .004" above 12" length
63 ✓	.002" up to and including 6" length .004" above 6" to and including 12" length .008" above 12" length
125 ✓	.004" up to and including 6" length .008" above 6" to and including 12" length .012" above 12" length

16.2.2 Parallelism of Machined Surfaces

- Parallelism Tolerance “Y” checked between two machined surfaces. The surfaces shall not be out-of-parallel more than “Y”, for any length.
- Tolerance “Y” shall be as table in Figure 30, but in no case shall exceed tolerance for “B” dimension.

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Figure 30

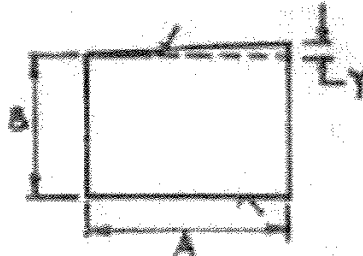


Table 12

Length A	Tolerance Y
Up to and including 1"	.002"
Over 1" to and including 6"	.004"
Over 6" to and including 12"	.008"
Over 12"	.016"

16.2.3 Squareness of Machined Surfaces

The tolerance on squareness of machined surfaces delineated on 900 shall be within values shown in table in Figure 31.

Figure 31

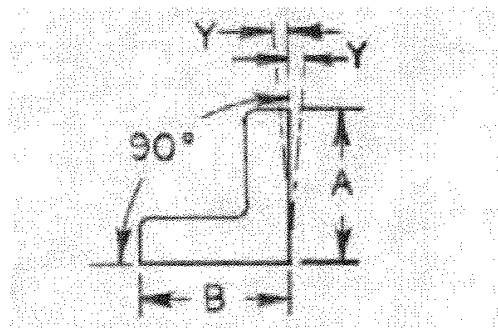


Table 13

Specified Surface Roughness	Dimension A up to & including 1 inch	Over 1 inch
16/	.0005"	.0005 in./in of "A"*
32/	.001"	.001 in./in. of "A"*
63/to & including 250/	.002"	.002 in./in. of "A"*
*But not to exceed tolerance for size on dimensions "A" or "B".		

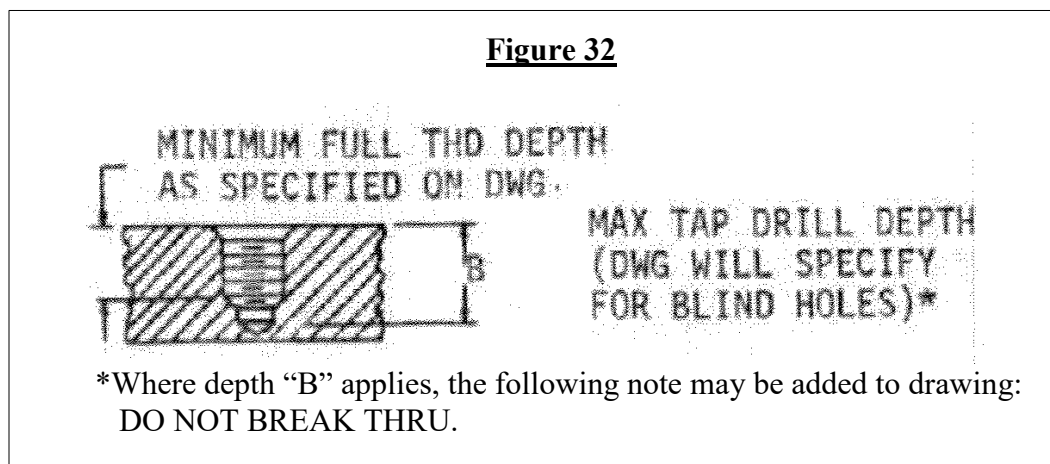
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17.0 TAPPED HOLES

17.1 Countersink For Tapped Holes and Tap Depths

- The thread length specified on the drawing shall be the length on full threads (gage fit).
- Imperfect threads will be permitted beyond the full thread length dimension to allow for lead on tap.
- Tapped holes shall be free of burrs and all foreign matter.



17.2 Countersink For Tapped Holes

- All tapped holes shall be countersunk before tapping to an included angle (80°-120°) and dia. "B". (See Countersink Data table in Figure 33).
- Through tapped holes should be countersunk at both ends where practicable. (See Figure 33.)
- Parts having thickness equal to four (4) threads or less shall be countersunk to the major diameter of the thread with a tolerance of ± 0.010 ".

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Figure 33

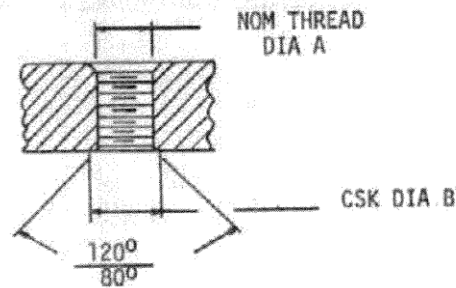


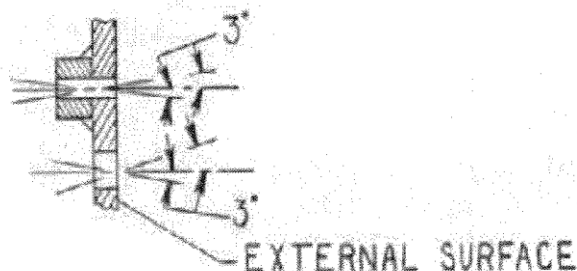
Table 14

Countersink Data	
A	B
No. 2 (.068")	.09" - .11"
No. 3 (.099")	.10" - .12"
No. 4 (.112")	.12" - .14"
No. 5 (.125")	.13" - .15"
No. 6 (.138")	.14" - .16"
No. 8 (.164")	.17" - .19"
No. 10 (.190")	.20" - .23"
No. 12 (.216")	.26" - .29"
¼ (.250")	.26" - .29"
Over ¼"	(A+.03") to (A+.06")

17.3 Angularity of Drilled and Tapped Holes

- The axis of a drilled or tapped hole in a fabricated frame shall be square with the surface from which drilling is done within 3° in any direction.
- When the external surface is to be machined after fabrication, the tolerance shall be 1° in any direction.

Figure 34



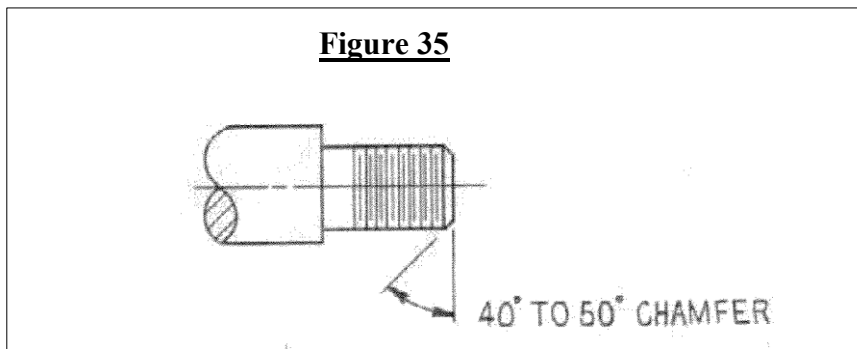
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18.0 THREADS

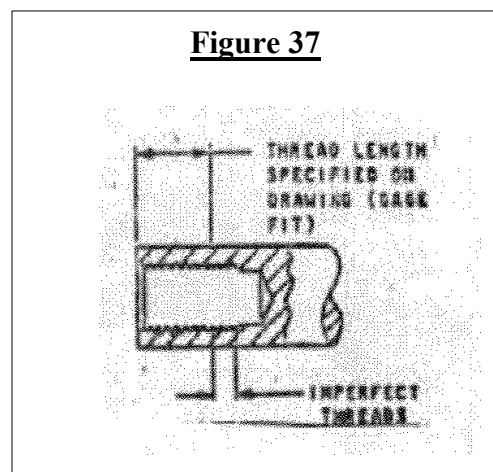
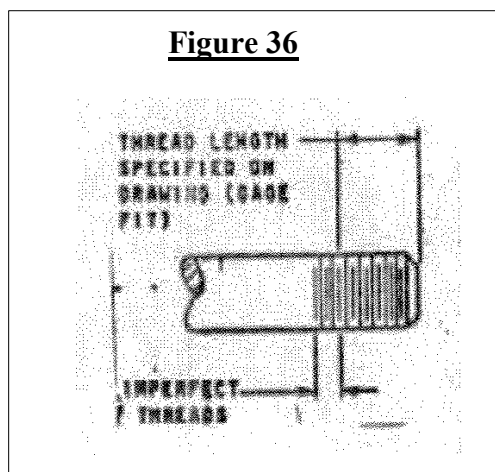
18.1 Chamfer on Threaded Ends (Except Rolled Threads)

- All external threaded ends shall be chamfered.
- Minimum chamfer shall extend to the root of thread.
- Maximum chamfer shall not extend below the root of a thread more than half the depth of thread.



18.2 Thread Length

- Thread length specified on drawing shall be for the length of full threads (gage fit).
- Unless otherwise specified on drawing, imperfect threads are permitted beyond this dimension for lead on tap or die.

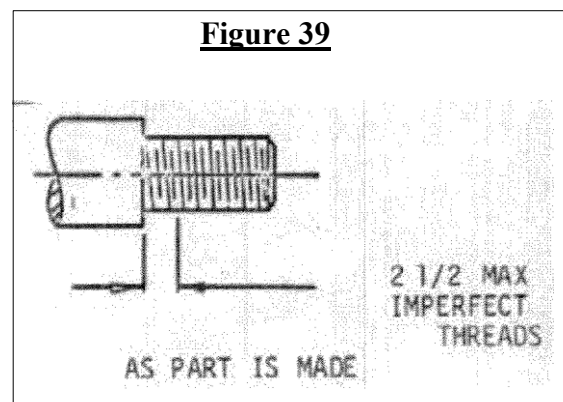
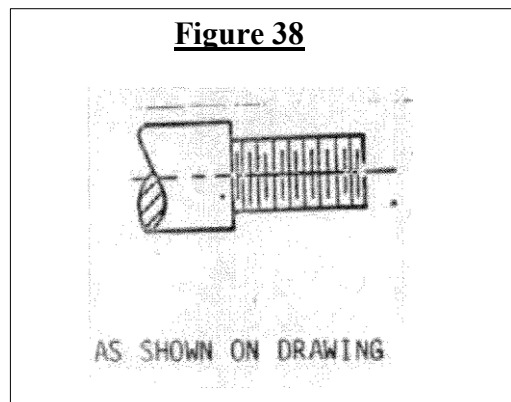


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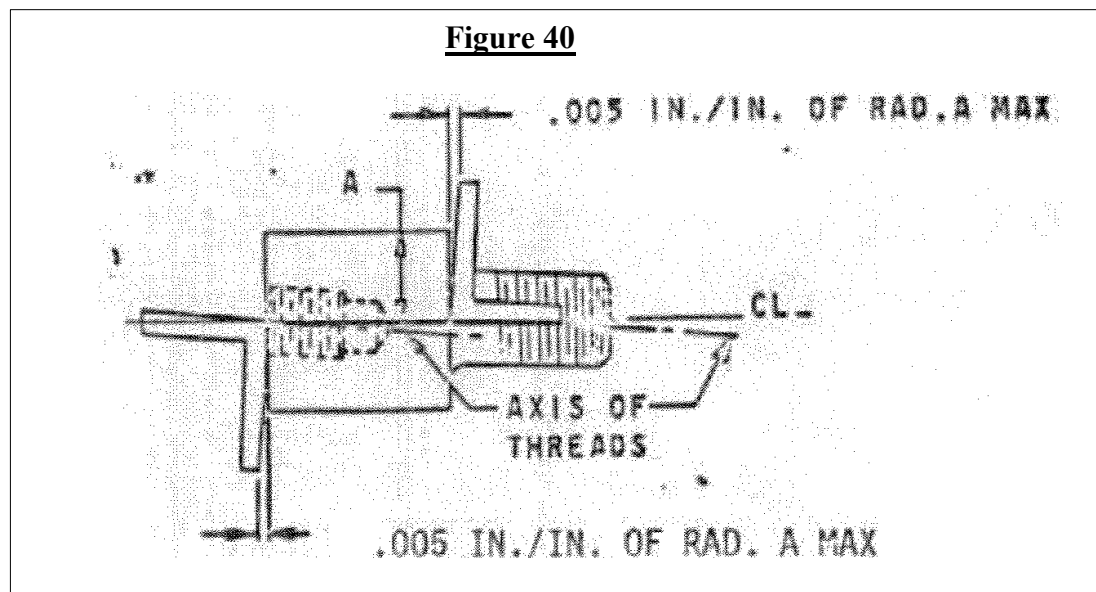
18.3 Thread to a Shoulder

- Unless an undercut is specified on drawing, no undercut will be permitted.
- Perfect threads must extend to within $2\frac{1}{2}$ threads of the shoulder.



18.4 Squareness and Concentricity of Threads

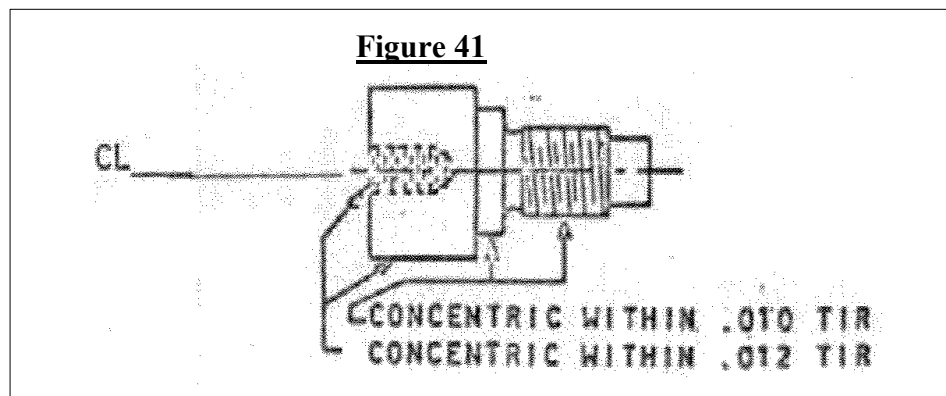
- The axis of the thread shall be square with adjacent face or shoulder within .005 in./in. of radius. (See Figure 40.)



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- b. External thread shall be concentric with the diameter on which it is cut or any other cylindrical machined surface, cold drawn, or centerless ground stock within .010" TIR; threaded holes within .012" TIR. (See Figure 41.)



19.0 TOOL RELIEF

19.1 Tool Relief for Grinding

A tool relief will be permitted at shoulders for all ground diameters in accordance with Figure 42, except with sharp corner is indicated.

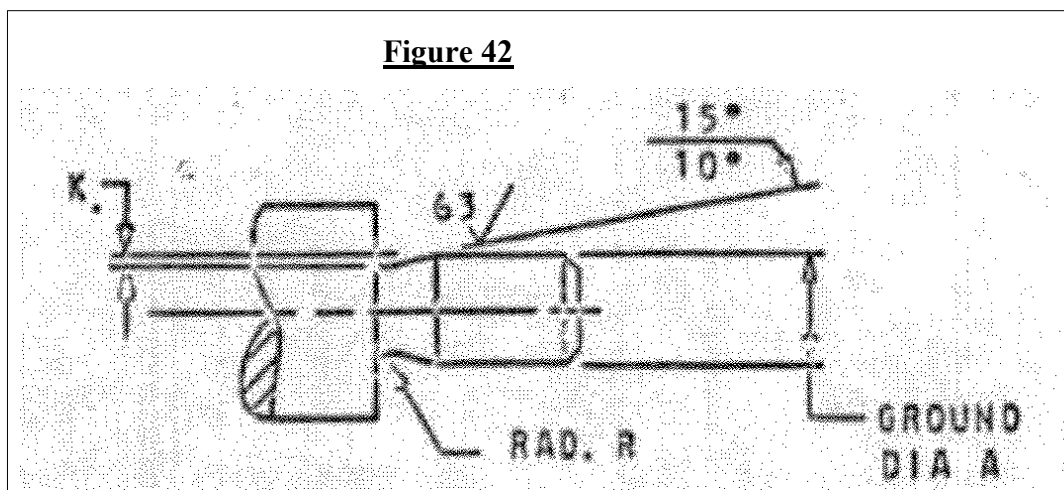


Table 15

Diameter A	Depth K	Radius R
.09" to .25"	.003" - .005"	.005" - .010"
Over .25" to .50"	.003" - .000"	.003" - .010"
Over .50"	.006" - .011"	.005" - .015"

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19.2 Tool Relief in Holes

When a tool relief is shown on the delineation for grinding to an internal corner but is not dimensioned, it shall be as shown in Figure 43.

Figure 43

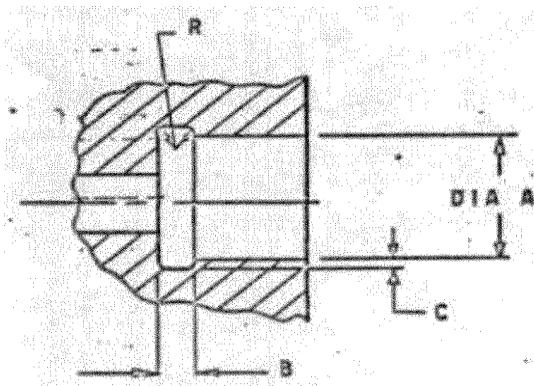


Table 16

Diameter A	B	C	R*
Up to and including .250"	<u>.035"</u> .025"	<u>.008"</u> .005"	.005" Max.
Over .250" to include .750"	<u>.050"</u> .040"	<u>.010"</u> .005"	.005" Max.
Over .750"	<u>.070"</u> .060"	<u>.015"</u> .010"	.010" Max.
*Configuration optional within limits of "R" but not sharp.			

20.0 TURNED PARTS

20.1 Centers for Machining

- Unless otherwise specified on the drawing, centers for machining will be permitted in the completed part.
- When centers are used, the maximum diameter "B", as shown in the Figure 49 table, shall be determined by the minimum diameter or groove, thread, etc., in the area of the centers.
- Centers may be the same size in both ends at the discretion of manufacturing.

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Figure 44

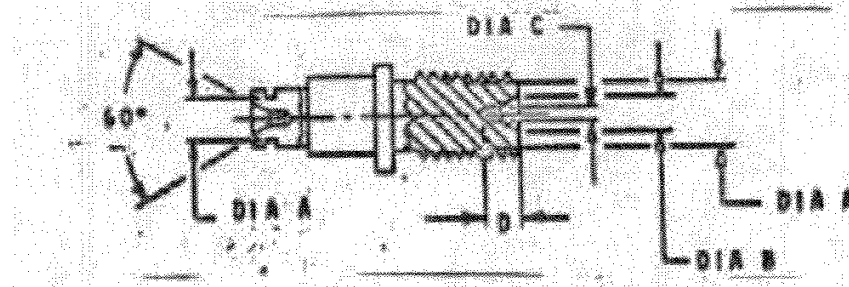


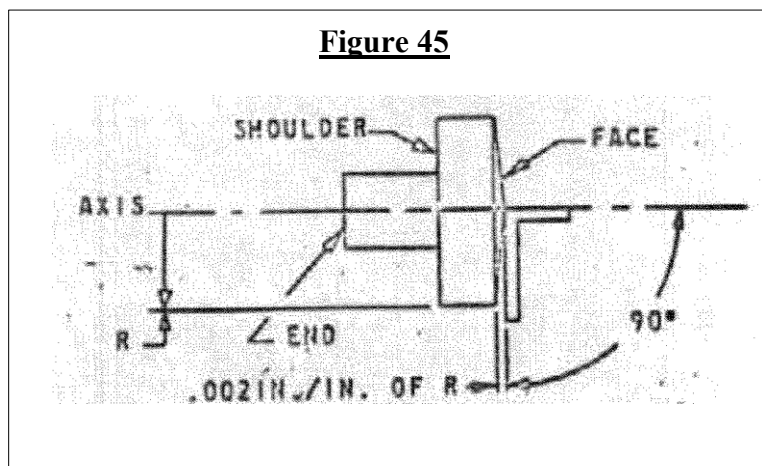
Table 17

Diameter A Minimum	B Max.	C	D	Center Drill #
.070" up to include .090"	.050"	.025"	.065"	---
.090" up to include .12"	.070"	1/32"	.084"	0
Over .12" up to include .15"	.082"	3/64"	.08"	1
Over .15" up to include .19"	.115"	5/64"	.11"	2
Over .19" up to include .25"	.131"		.12"	
Over .25" up to include .38"	.162"		.14"	
Over .38" up to include .62"	.225"	1/8"	.20"	4
Over .62" up to include 1.00"	.256"		.33"	
Over 1.00" up to include 1.50"	.350"	3/16"	.31"	5
Over 1.50" up to include 2.00"	.381"		.34"	

20.2 Squariness of Ends, Faces And Shoulders

- The squariness of ends, faces and shoulders delineated at right angle to the axis of rotation shall be within .002" maximum up to 1" radius. Above 1" radius, the squariness shall be within .002 in./in. of radius "R". (See Figure 45.)
- Special tolerances which apply to certain features of gear blanks are specified on the gear drawings.

Figure 45

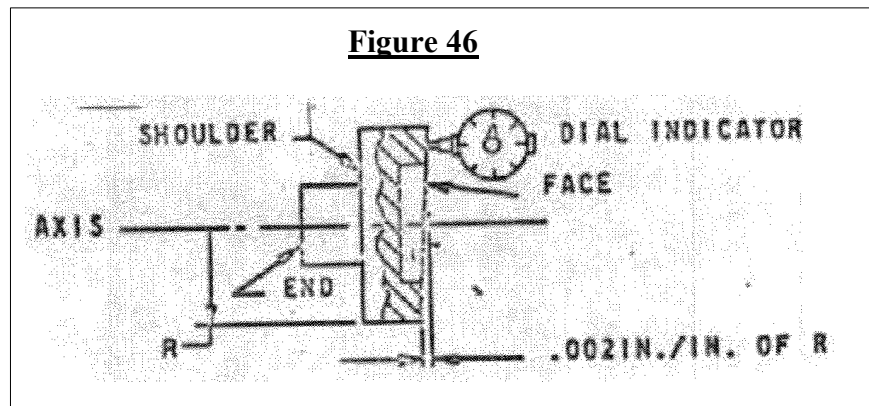


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20.3 Lateral Run-out

- The lateral run-out (total indicator reading, TIR) for ends, shoulders and faces shall be .002" max. up to 1" radius.
- Above 1" radius, the lateral run-out shall be within .002 in./in. of radius "R", but shall not exceed .005" at any radius. (See Figure 46.)
- Special tolerances which apply to certain features of gear blanks are specified on the gear drawings.



20.4 Internal Corners

See Section 9.0.

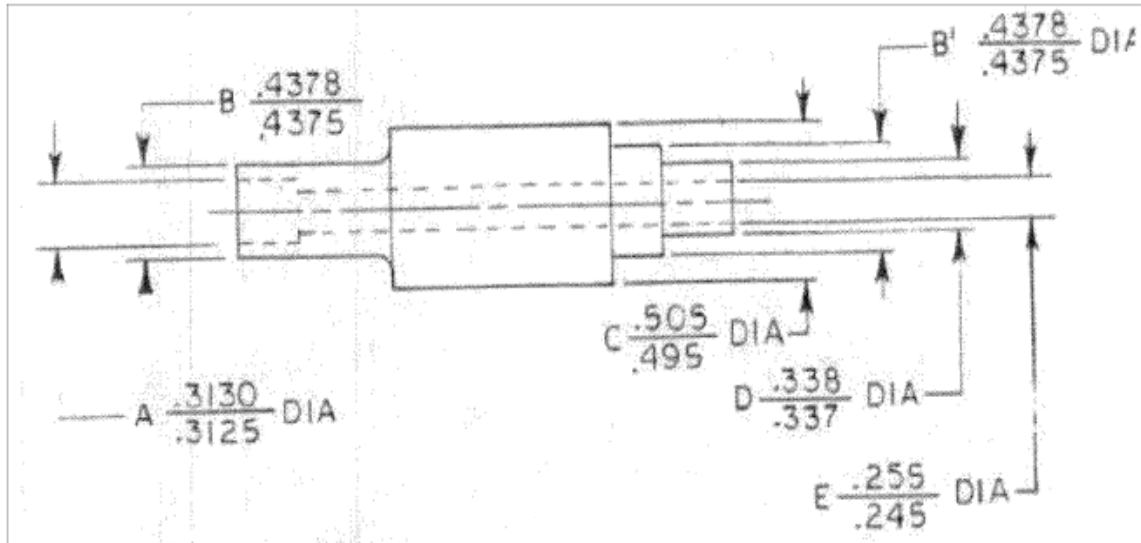
20.5 Concentricity and Roundness of Cylindrical Surfaces

- The total run-out is the TIR on a surface when the part is rotated 360° about the axis of a controlled diameter.
- The controlled diameter shall be the diameter dimensioned with the smallest tolerances. The total run-out includes out of roundness and eccentricity.
- The total run-out between the controlled diameter and any other diameter shall not exceed the arithmetical sum of the tolerances specified on the drawing for these diameters. (See Figure 47.)
- Special tolerances which apply to certain features of gear blanks are specified on the gear drawing.

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Figure 47*



*Controlled diameter equals "B" or B¹.

Table 18

Maximum TIR Between	Equals
A+B	.0008"
B+C	.0103"
B+D	.0013"
B+E	.0103"
B+B ¹	.0006"

20.6 Straightness of Cylindrical Parts

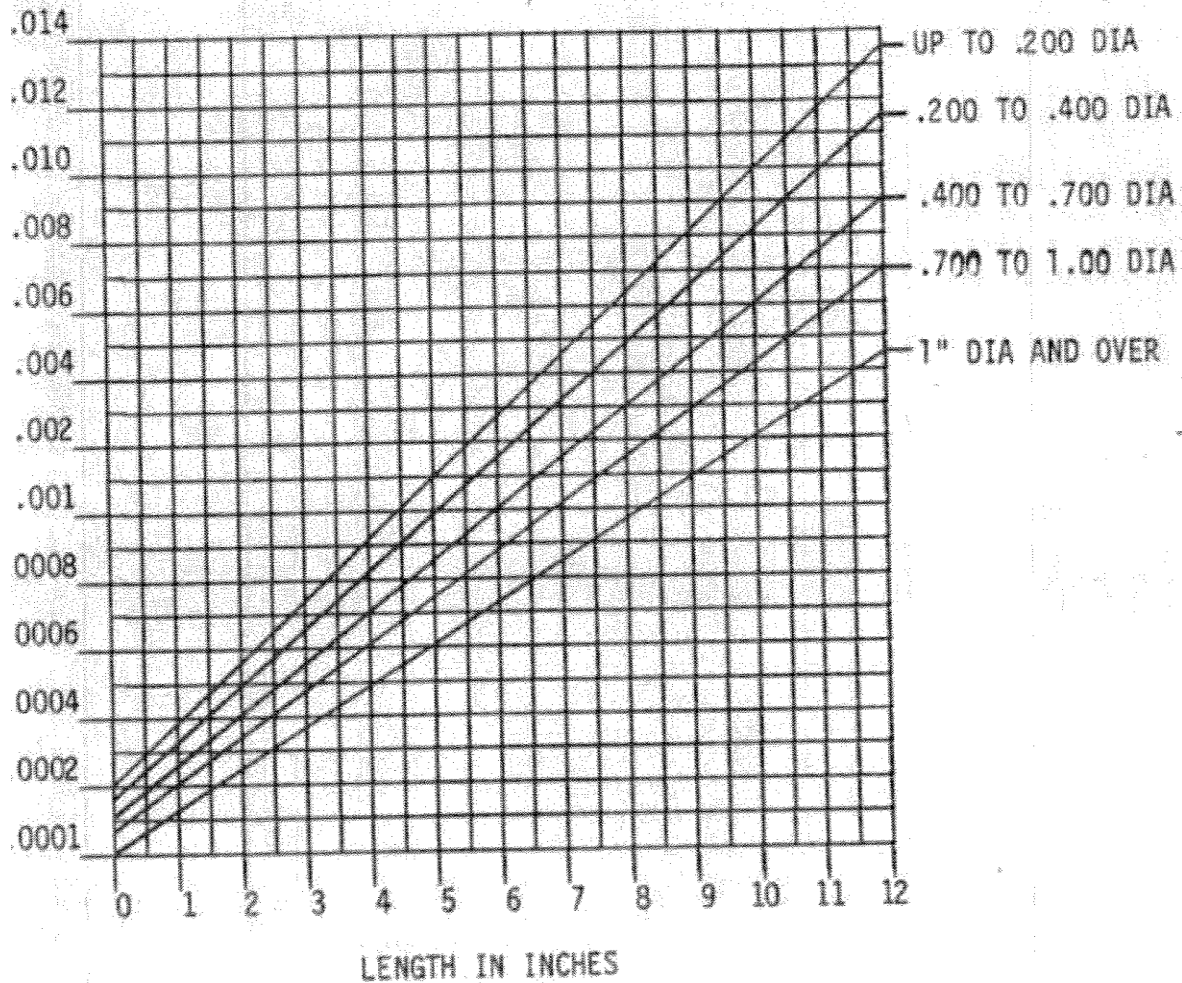
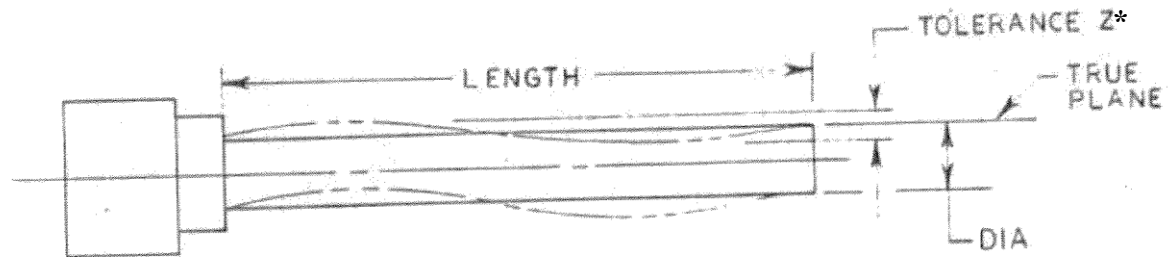
- Machined cylindrical parts will be straight within tolerance specified in table with Figure 48.
- For lengths in excess of 12", the drawing shall specify the required straightness tolerance.

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Figure 48



* Tolerance "Z" in inches.

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21.0 RECORDS AND FORMS

- a. Records and forms required by the procedures of this standard shall be maintained in accordance with SPR 1440.1.
- b. All records and forms are assumed to be the latest edition unless otherwise indicated.
- c. Forms may be obtained from the SSC Electronic Forms repository or from the NASA SSC Forms Management Officer. Quality Records are identified in the SSC Master Records Index.

22.0 ACRONYMS AND ABBREVIATIONS

ANPT	Aeronautical National Pipe Taper
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
°	Degrees
F	Fahrenheit
FED	Federal
"	Inch
NASA	National Aeronautics and Space Administration
NPT	National Pipe Thread
SAE	Society of Automotive Engineers
SPR	Stennis Procedural Requirement
SSC	John C. Stennis Space Center
SSTD	John C. Stennis Space Center Standard
TIR	Total Indicator Run-out