



Machining Standards Manual

June 21, 2002

15.0 MACHINING

15.1 MACHINING - GENERAL

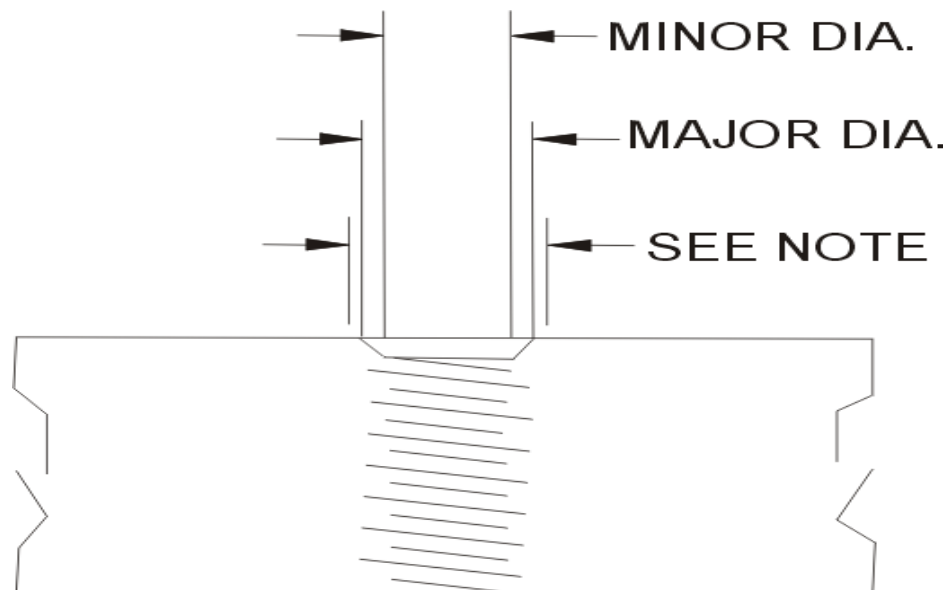
This section of the manual covers the workmanship standards for fabrication of machined parts and assemblies.

15.1.1 Finish of Machined Surfaces

Unless otherwise specified, all machined surfaces shall have a surface finish of 125 or better.

15.1.2. Countersinking

NOTE: All tapped holes in flat workpieces shall be countersunk to a depth that causes the greatest diameter of the countersinking operation to be at least as large as the major thread diameter and not larger than the difference between the major and minor thread diameters beyond the major thread diameter.

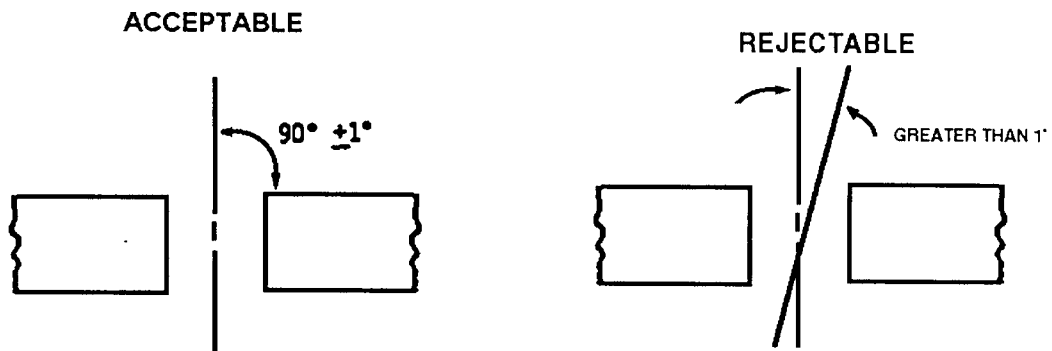


On drilled holes in flat workpieces, minimum material required to break sharp edge and deburr only, shall be removed.

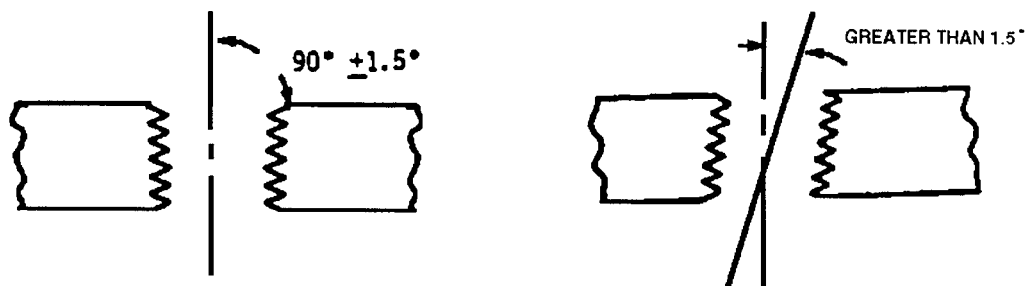
Tapped or drilled holes in shafts or irregular surfaces shall be brushed or sanded to removed burrs.

15.1.3 Perpendicularity

For holes drilled into materials over .125" deep or drilled through material over .125" thick, the hole shall be within 1° of being perpendicular.



For tapped holes into materials over .125" deep or tapped through material over .125" thick, the tapped hole shall be within 1.5° of being perpendicular.



15.1.4 Hole Spacing on a Bolt Circle

Deviation from true location of any individual hole shall not exceed $\frac{1}{2}$ of total tolerance on diameter of bolt circle. For symmetrical tolerances this is equal to the given tolerance.

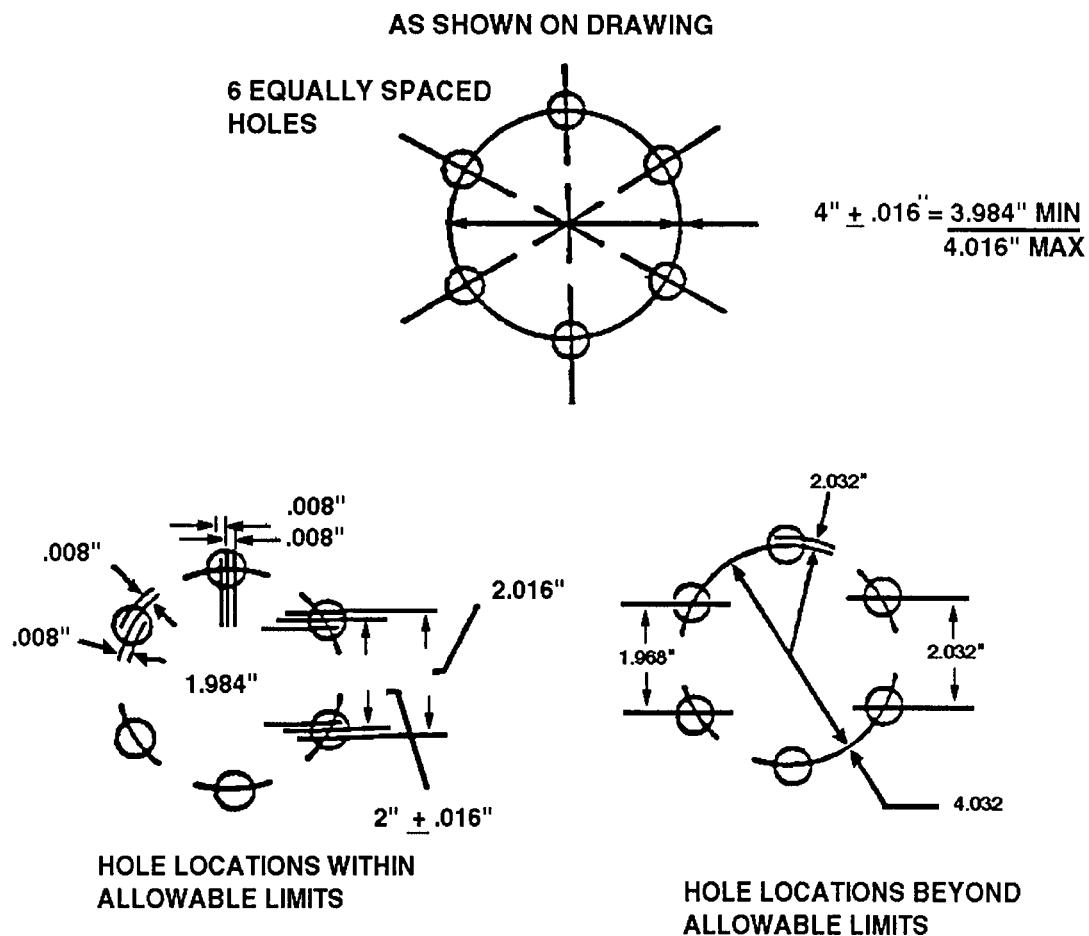
Example: If given tolerance = $\pm .016$ then total tolerance = $.032$ ".

$$\frac{1}{2} \text{ of } .032 = .016" = \text{given tolerance}$$

For nonsymmetrical tolerances this will be different than the given tolerance.

Example: If given tolerance = $\pm .016 / -.010$, then total tolerance = $.026$ ".

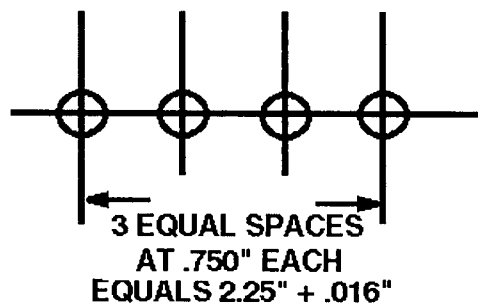
$$\frac{1}{2} \text{ of } .026" = .013" \neq \text{given tolerance.}$$



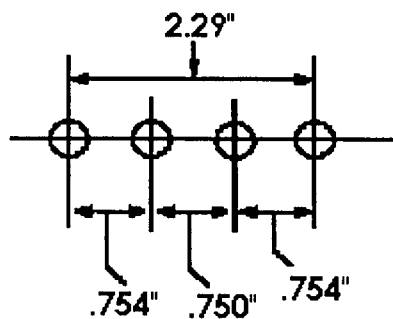
15.1.5 Hole Spacing on a Straight Line

Deviation from true location of any individual hole shall not exceed $\frac{1}{2}$ of total tolerance on overall dimension ($\frac{1}{2}$ of $.032" = .016"$).

AS SHOWN ON DRAWING

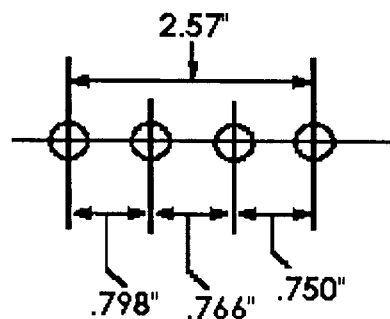


ACCEPTABLE



**EACH HOLE IS WITHIN .008"
OF TRUE LOCATION**

REJECTABLE

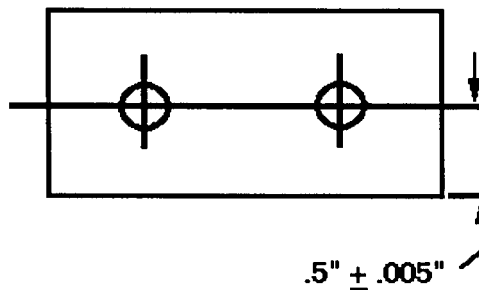


**HOLES ARE GREATER THAN .008"
FROM THE TRUE LOCATION**

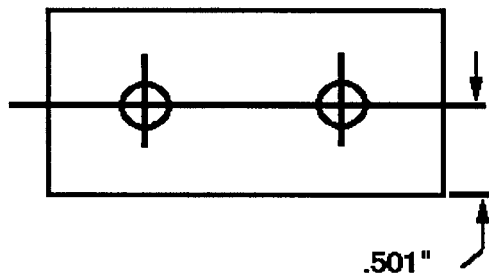
15.1.6 Hole Location on Center Line

Deviation of holes from their true location shall not exceed $\frac{1}{2}$ of total tolerance ($\frac{1}{2}$ of $.010" = .005"$) away from center line. (Machined parts only).

AS SHOWN ON DRAWING

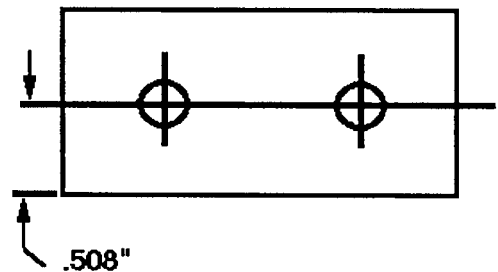


ACCEPTABLE



WITHIN $\frac{1}{2}$ OF TOTAL TOLERANCE

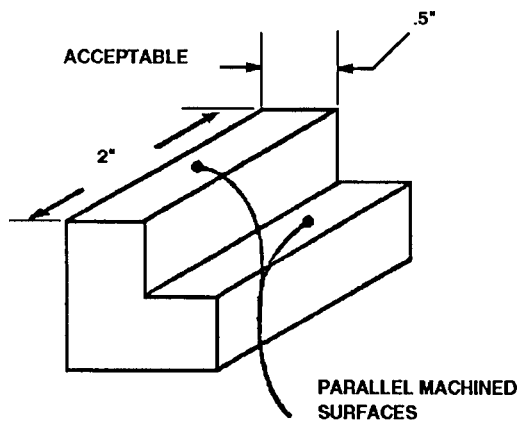
REJECTABLE



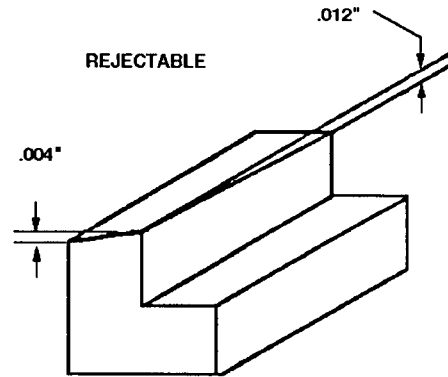
BEYOND $\frac{1}{2}$ OF TOTAL TOLERANCE

15.2 PARALLELISM AND PERPENDICULARITY

Parallel machined surfaces shall be parallel within a rate of .005" per 1".
Machined surfaces shall be perpendicular 90° within .005" per 1".



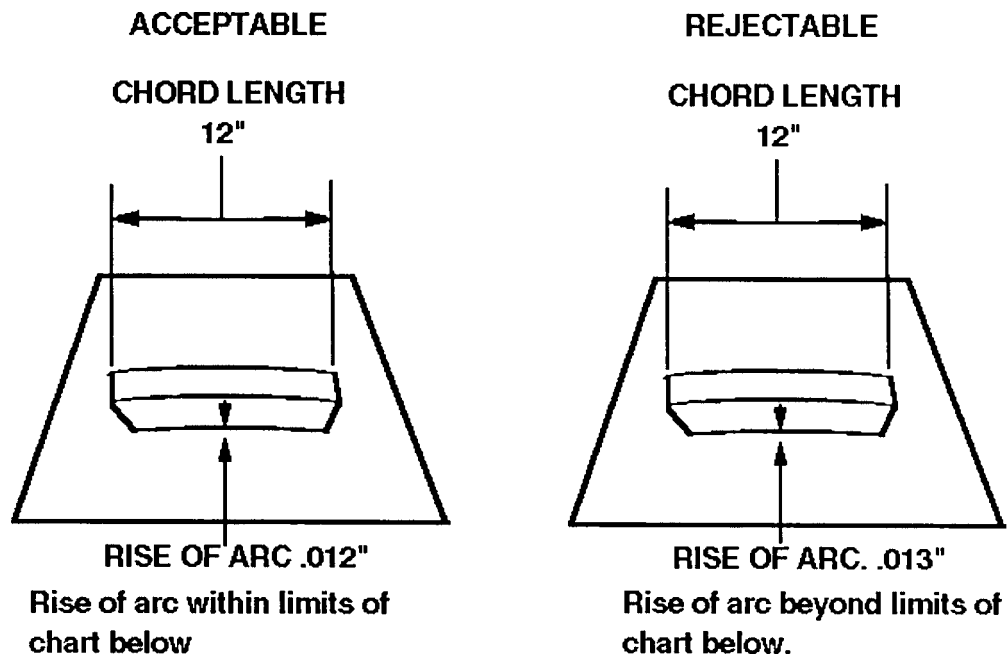
**SURFACES ARE PARALLEL AND
SQUARE TO WITHIN LIMITS**



SURFACES EXCEED TOTAL TOLERANCES.

15.3 STRAIGHTNESS OF NONMACHINED SURFACES

(ON PARTS MADE FROM BARS, RODS, EXTRUSIONS OR TUBING)



VARIATIONS FROM STRAIGHTNESS

Chord length	0-1 ft	1-2 ft	2-3 ft	3-4 ft	over 4 ft
Allowable Rise of arc	.001"	.0015/1"	.002/1"	.003/1"	.004/1"

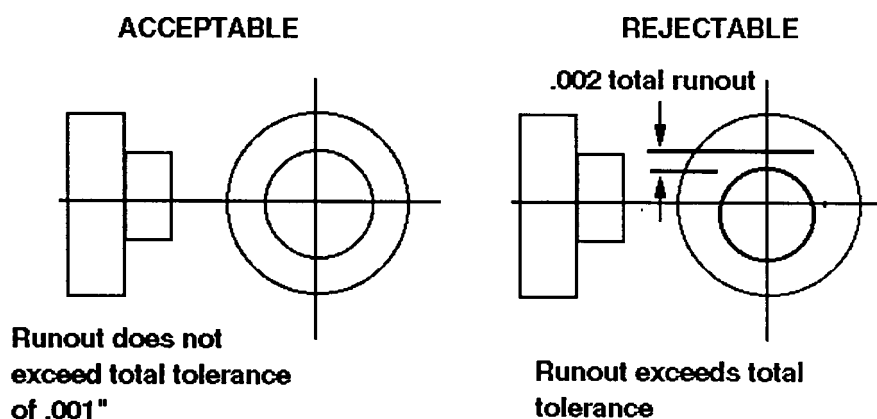
15.4 RUNOUT

15.4.1 Runout on Diameters

The true indicated runout on any diameter with respect to any other diameter with the same center axis shall not exceed twice the smallest runout tolerance for either diameter.

Minimum tolerance of diameter = $\pm .0005"$

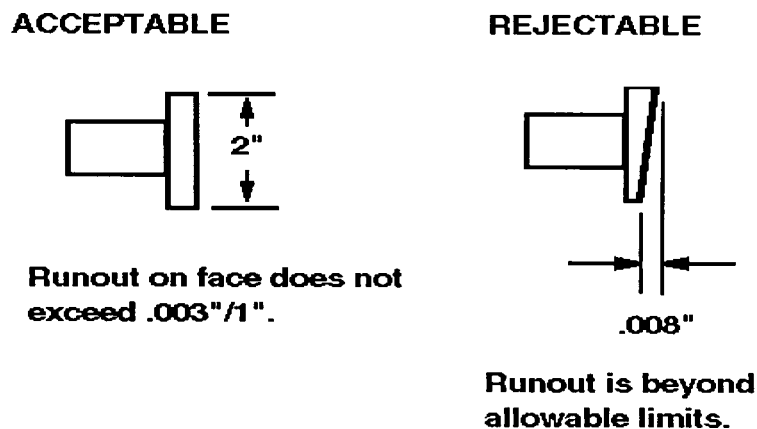
Total tolerance = $2 \times .0005" = .001"$



15.4.2 Runout on Face

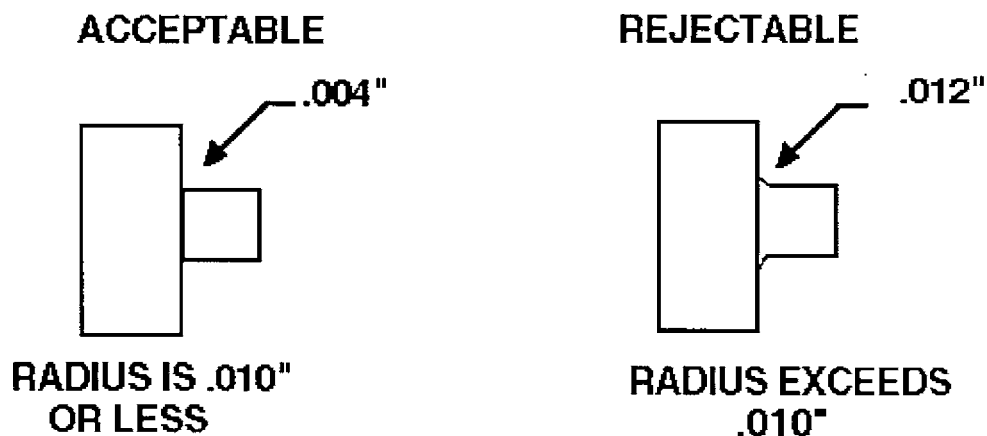
Runout on any face, with respect to axis or outside diameter, shall not exceed .003" per 1" of face diameter.

Allowable tolerance = $2 \times .003" = .006"$



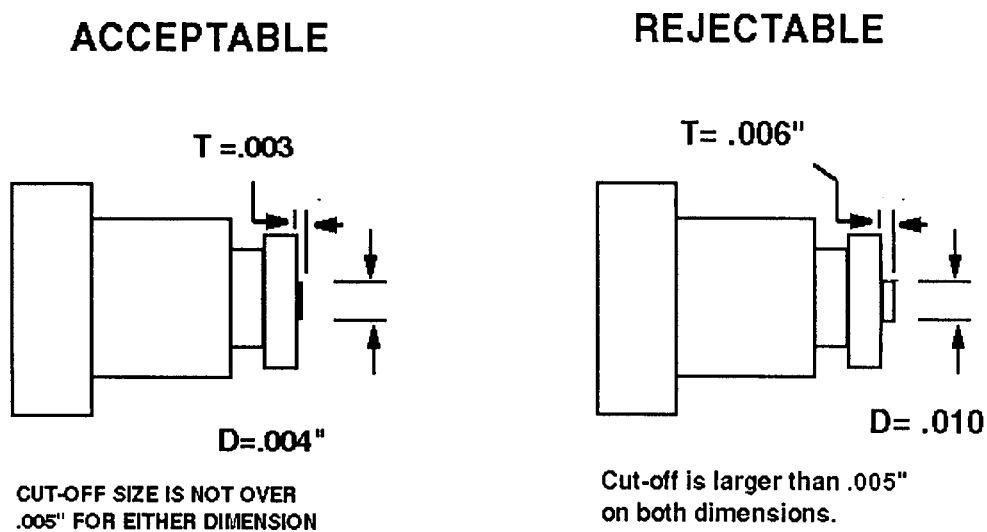
15.5 MAXIMUM ALLOWABLE INSIDE RADIUS FOR TURNED PARTS

The inside corner radius of turned parts shall not exceed .010".



15.6 ALLOWABLE SCREW MACHINE OR LATHE CUT-OFF

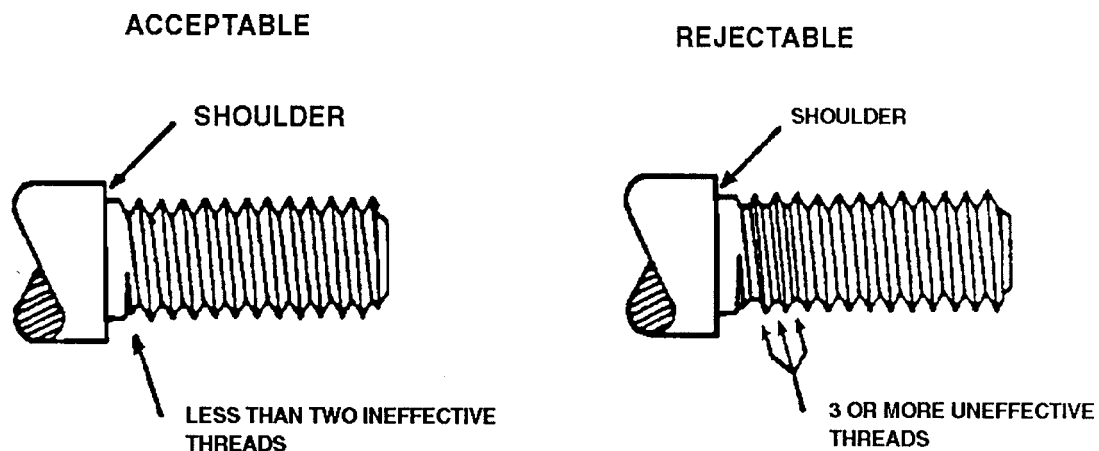
The diameter (D) or thickness (T) of the cut-off shall not be greater than .005" on either dimension.



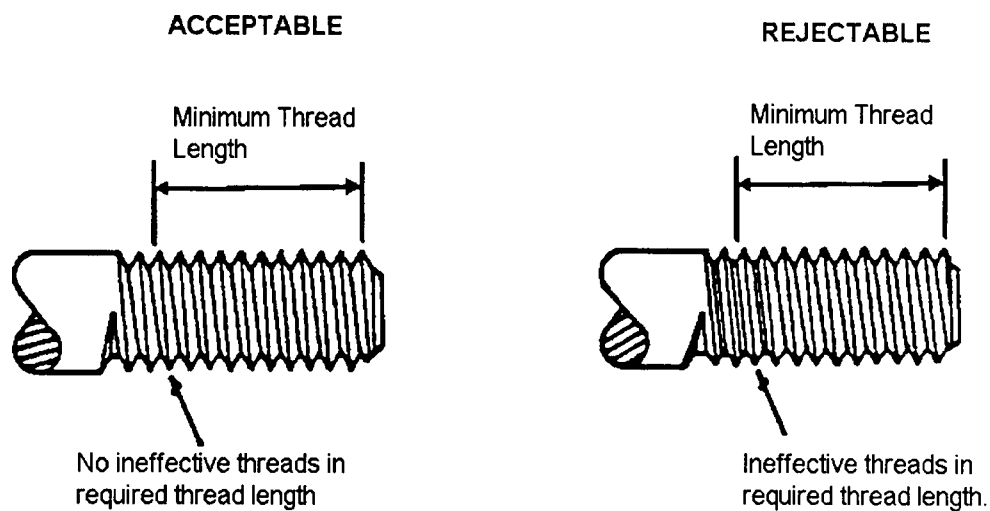
15.7 EXTERNAL THREADS

15.7.1 External Threads Up To Shoulder

Complete and effective threads shall extend to within two threads of the shoulder.



15.7.2 External Threads Up To Shaft



No ineffective threads within required minimum thread length. Maximum of two incomplete threads for tool runout.

15.8 INTERNAL THREADS

15.8.1 Internal Threads, Threaded Through Hole

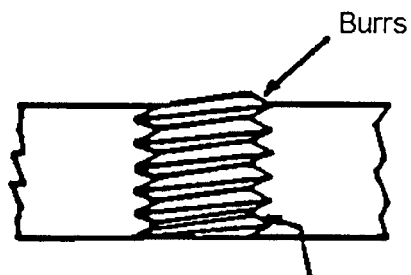
Complete and effective threads shall extend through the total depth of the hole. No burrs, visual imperfections or damaged threads are allowed.

ACCEPTABLE



No burrs or ineffective threads

REJECTABLE

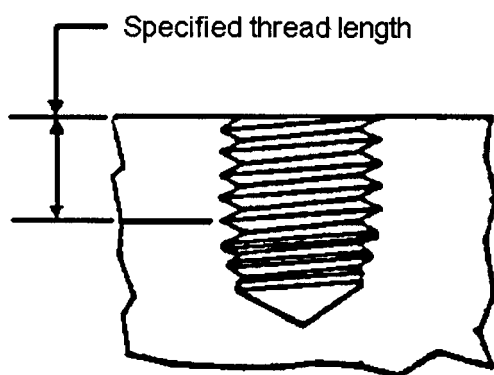


Ineffective threads

15.8.2 Internal Threads, Threaded Into a Blind Hole

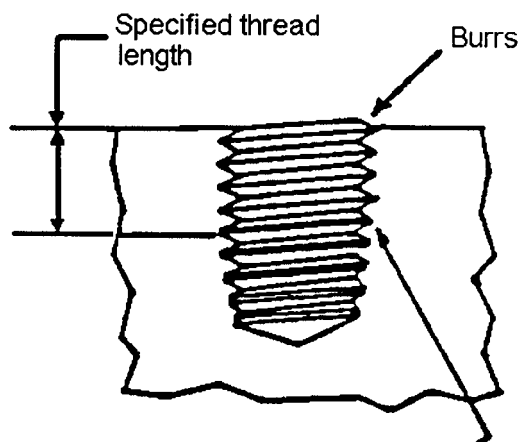
No incomplete or ineffective threads in the specified thread length. No burrs, visual imperfections or damaged threads are allowed.

ACCEPTABLE



No burrs or ineffective threads

REJECTABLE



Ineffective threads