MOOG

MACHINING SUPPLIER WORKMANSHIP STANDARDS

Issue: 1-APRIL- 2007

INTRODUCTION

Supported by valued suppliers, Moog has developed a reputation for quality, performance and delivery that has helped it to become a leading supplier of highly sophisticated control systems. Quality workmanship will help Moog products to meet or exceed customer expectations, and assure our mutual success in the marketplace.

This document supplements engineering drawings and purchase order requirements for machined parts. In the event of conflict, engineering drawings and purchase order requirements shall take precedence.

TRACEABILITY

Each lot of material issued by Moog is designated by a traceability (work order, receiver or purchase order) number. In order to preserve required traceability, make sure that:

- Individual lots of material are not mixed
- Items produced from different lots of Moog-supplied material are organized into separate lots
- Items produced can be traced to the specific lot of Moog-supplied material used

HANDLING & PACKAGING

Parts should be handled and packaged as required to preserve lot identity, and prevent damage.

Completed parts should be cleaned and, if required, protected using an appropriate corrosion preventive prior to packaging. Packaging should prevent damage due to contact of parts with one another during shipment.

GUIDELINES FOR MACHINING

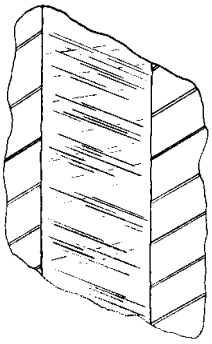
Guidelines for the following are presented on the following sections.

1. ELECTRICAL-DISCHARGE MACHINING (EDM)

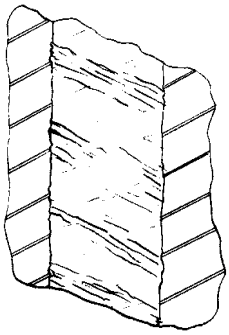
EDM surfaces should be free of particles (spherical globules, splatter) eroded from base material, and carbon-like layered deposits. Removal should be performed using an appropriate process (liquid honing, wet blasting, for example) having minimal affect on close tolerance features. Resulting contaminants must be removed from recesses and blind holes.

2. MACHINED HOLE SURFACES

Surfaces of machined holes should be free of stripped and potentially loose metal particles.

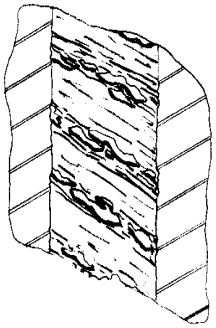


Uniform surface



Rough surface but no potentially loose particles

ACCEPTABLE

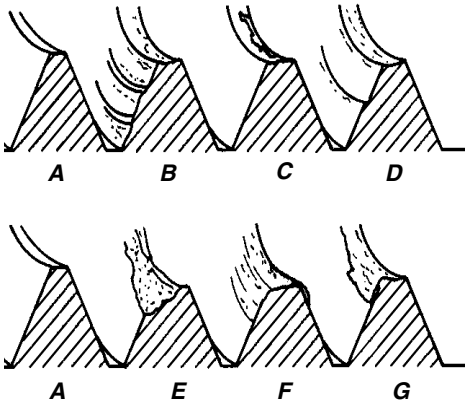


Potentially loose friction welded particles

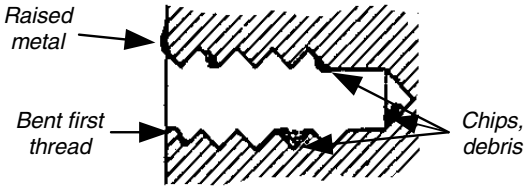
UNACCEPTABLE

3. THREADED BORES/HOLES

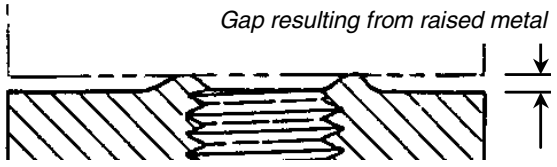
Threaded bores/holes should be free of chips, burrs and major discontinuities. Chips and dislodged burrs may degrade or entirely disable systems, while major discontinuities may damage mating parts or complicate assembly.



- ***A*** *- As designed thread configuration*
- ***B*** *- Tool marks or ribbed sidewall;* ***ACCEPTABLE***
- ***C*** *–Burr rolled over material on crest; UNACCEPTABLE*
- ***D*** *- Stepped sidewall and crest;* ***ACCEPTABLE***
- ***E*** *- Torn sidewall & crest;* ***UNACCEPTABLE*** *unless sharp edges are blended*
- ***F*** *- Loose burr turned partially concealed on sidewall;* ***UNACCEPTABLE***
- ***G*** *- Same condition as in F shown in the exposed position;* ***UNACCEPTABLE***



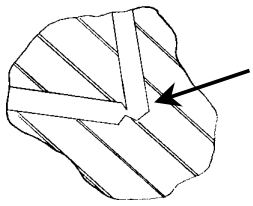
UNACCEPTABLE Conditions in Threaded Holes



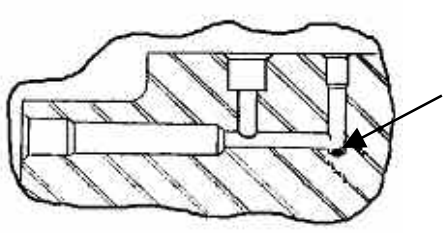
Extruded Material Surrounding Threaded Hole
UNACCEPTABLE

4. **INTERSECTING PASSAGES**

Intersecting passages form essential flow paths that must be free of restrictions and debris. Intersections should be verified, and passages should be free of chips and burrs.



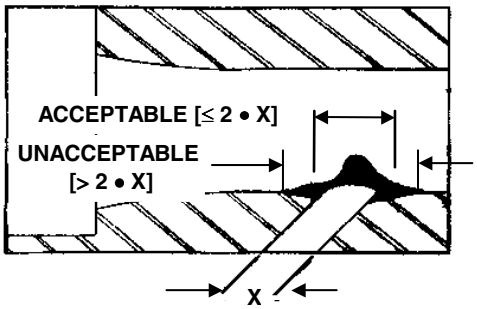
Restriction due to error in hole position or angle



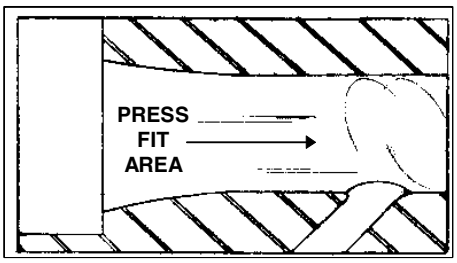
Debris trapped in flow path

5. **BORES (Lead, Intersections and Surfaces)**

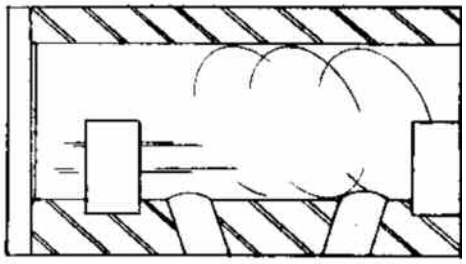
For flow passage edge breaks, washout resulting from deburring should not exceed an area twice the diameter of the flow passage in the longitudinal direction.



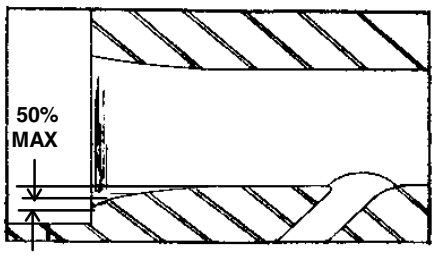
Critical bores with ≥ 32 RHR finish must be free of scratches and other defects that may create leakage paths.



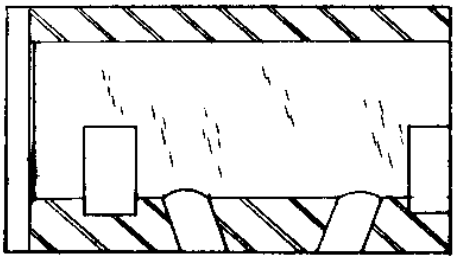
UNACCEPTABLE Potential leakage paths in longitudinal scores, scratches, and radial marks in surface that contacts press fit part



UNACCEPTABLE Potential leakage paths in longitudinal scores and radial marks in seal-contacting surface



Scoring and minor tool marks remaining after polishing but not extending more than 50% into the polished region are ACCEPTABLE



Clean up, grind checks and minute imperfections are ACCEPTABLE providing potential leakage paths are not established

6. BURRS

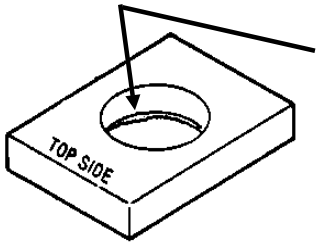
Edges should comply with drawing edge break requirements and be free of burrs. When dislodged, burrs may cause product failures, adversely affect subsequent machining and dimensional inspections, and damage other parts. While ultimate acceptance criteria depends upon factors including product application, burrs that are visible at 5-10X magnification or may be dislodged should be removed.

A variety of text books *(incl. Hand Deburring: Increasing Shop Productivity - Laroux K. Gillespie; Society of Manufacturing Engineering; ISBN 0-87263-642-9)* cover deburring in detail.

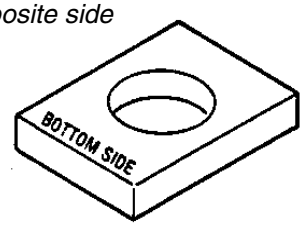
Detection

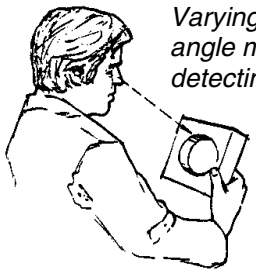
Consideration for the following may simplify the burr detection process:

- Part cleanliness - Cleanliness may be essential for efficiently detecting burrs. Confused with dirt or other contaminants, burrs may be overlooked.
- Viewing angle - Frequently, easily detectable burrs are overlooked when viewing a part from an single direction. It is good practice to view from varying directions and angles. In general, parts should not be viewed with the line of sight between 30° to 60° to the edge or surface being inspected.



Burrs visible from one side, may not be visible from the opposite side

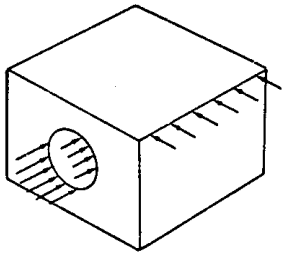


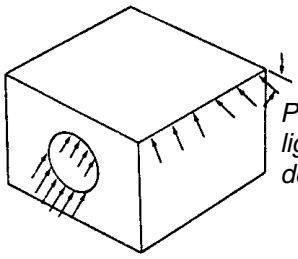


Varying viewing angle may aid in detecting burrs

- Proper lighting - Similar to viewing angles, lighting should be at an angle of 30° to 60° to the surface being inspected. Intensity, type, color and angle of lighting used, shall be mainly dictated by the size, shape, material and detail of the work piece.

90° lighting angle hinders burr detection.





Preferred (30° - 60°) lighting angle aids in detecting burrs.

- Inspection aids - Eye loupes, microscopes and other inspection equipment aid in detecting burrs.

Removal

Methods for removing burrs may be influenced by factors including:

- Feature tolerances
- Part geometry
- Material hardness
- Dimensions near Least Material Condition (LMC)
- Critical (≥ 32 RHR finish) surfaces nearby
- Contamination produced

NOTE

Use of glass beads for any purpose on any product to be delivered to Moog is prohibited.

Depending upon the deburring process, it may be advisable to:

- Verify compliance with drawing requirements
- Inspect recesses (blind holes, interconnecting passages, etc.) for migrated particles
- Verify that all burrs have been removed
- Inspect for, and remove, contamination

BURRS *(Continued)*

Geometry Challenges

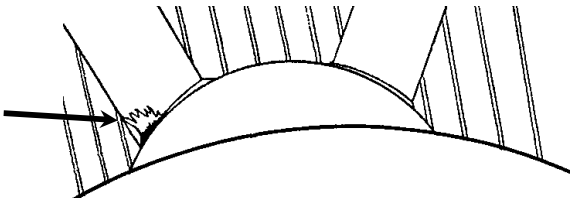
Part geometry may present challenges to detecting or removing burrs.

- Holes - Dependent upon the material, machining process, and dimensions, difficult to detect burrs and other imperfections may be created.

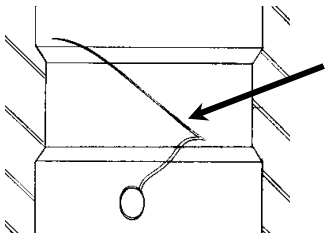
Feathered burr *(UNACCEPTABLE) - Difficult to detect*

- Scalloped recesses - Burrs and contaminants may be hidden from view.

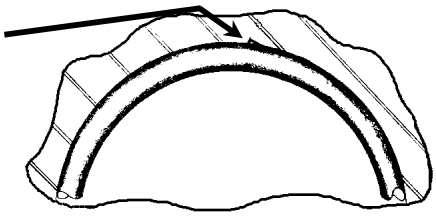
Burr in recess that may be hidden from view



- Seal surfaces - Typically machined to a ± .001 inch tolerance with 32 RHR surface finish, sealing surfaces are susceptible to scratches that may result in fluid leakage around O-ring and elastomeric seals.



UNACCEPTABLE Scratches completely across seal surfaces



- Blind threaded holes - Debris and contaminants accumulated should be removed using care to prevent damage to threads.
- Interconnecting passages - Passage intersections must be free of restrictions and debris (ref. section 4).
- Threaded bores - Threaded bores should be free of chips and burrs (ref. section 3).