

Engineering Requirements for Shop Practice

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1. SCOPE

This standard specifies the shop practices and good workmanship required in the manufacture of individual parts and assemblies when not specified on the Engineering drawings. Specific requirements stated on Engineering drawings supersede any requirements of this standard. Tolerances and conventions listed in this standard are within normal practices acceptable in industry.

2. DESIGNATION

Drawings of sheet metal parts, machined parts, weld assemblies, and painted surface parts released after April 1994 shall have this standard listed in the "Applicable Standards" block on the drawing in accordance with Section 7 of Standard 86511126 (FNHA-3-B-100.00).

3. RELATED SPECIFICATIONS

3.1 REFERENCE STANDARDS

86529681 (FNHA-3-A-008.00)—Material Qualities and Torques for Standard Hardware
 86529507 (FNHA-3-A-215.00)—Alignment Tolerance for Keyways and Holes
 86529543 (FNHA-3-A-220.00)—Center Drill
 86511126 (FNHA-3-B-100.00)—Reference Standards on Drawings
 86508280 (FNHA-3-B-132.00)—Decal Placement
 86507097 (FNHA-4-A-005.00)—Casting Quality
 86574453 (FNHA-4-A-006.00)—Welding Quality
 86529862 (FNHA-4-A-007.00)—Surface Requirements

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4. FUNDAMENTAL RULES

4.1 DEFINITIONS

4.1.1 Maximum Material Condition (MMC)—That condition of a part feature wherein it contains the maximum amount of material. Example: Minimum hole size and maximum shaft size. “Maximum material condition” might also be considered as nothing but a “new” term for an “old” situation, such as the familiar terms “worst condition”, “critical size”, etc., used in the past for relating mating part features.

4.1.2 Regardless of Feature Size (RFS)—The tolerance of form of a feature must be met regardless of where the feature lies within its size tolerance.

4.1.6 Fisheye Defect—A surface depression or crater in the paint film. Fisheyes are caused by the repulsion of the wet paint by a surface contaminate such as oil or silicone materials.

4.1.7 Orange Peel—An irregularity in the surface of a paint film resulting from the inability of the wet film to “level out” after being applied. Orange peel appears as a characteristically uneven or dimpled surface to the eye, but usually feels smooth to the touch.

4.1.8 Runs or Sags—The downward flow of a wet paint as a results of its being applied too heavy or too fluid.

4.1.9 Scratch—A line which has broken the surface of the dry paint film and may extend to the substrate on which the paint is applied.

4.1.10 Overspray—Sprayed paint which misses the area being painted and falls upon the surrounding surfaces.

4.2 RULES

4.2.1 Rule 1—The control of geometric form prescribed by limits of size and this standard does not apply to the following:

4.2.1.1 Stock such as bars, sheets, tubing, structural shapes, and other items produced to established industry standards which prescribe limits for straightness, flatness, and other geometric characteristics. Unless geometric tolerance or surface textures are specified on the drawing of a part made from these items, standards for the items govern the surfaces that remain in the “as furnished” condition on the finished part.

4.2.1.2 Material in process and surfaces that are consumed in a later manufacturing operation such as welding, shearing, and machining. Standards for these must be governed by the Manufacturing plant.

4.2.2 Rule 2—All dimensions apply when parts or assemblies are free from restraining forces (in free state). When part size is in dispute, measure at or mathematically adjust to 20°C (68°F) and 50% relative humidity.

4.2.3 Rule 3—Although the tolerances in this standard represent maximum and minimum conditions, it is the operator’s responsibility to always attempt to run parts to nominal condition when possible. This approach will assist subsequent operations as well as welding and assembly.

NOTE: Dimensions shown in this publication are metric.

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5. SHEET METAL PRACTICES

5.1 PURPOSE

To establish requirements and acceptance criteria for sheet metal parts.

5.2 SCOPE

This specification defines the limits of acceptability of characteristics resulting from the forming, bending, blanking, or perforating of sheet metal parts.

5.3 APPLICABILITY

This specification is applicable to all Engineering drawings. If any requirements in this specification

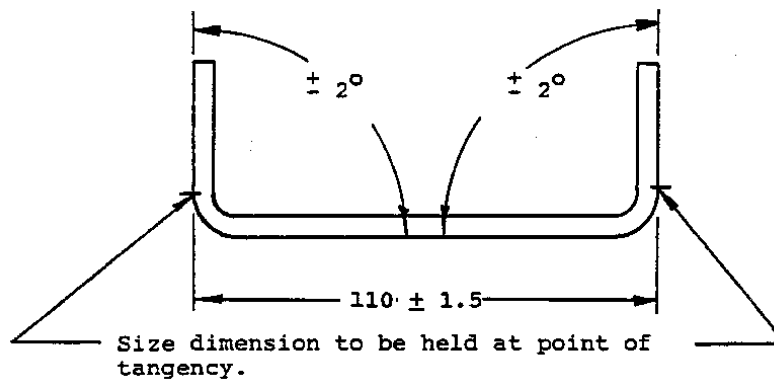
differ from the requirements of the Engineering drawing, the Engineering drawing takes precedence.

5.4 BENDING

5.4.1 Angles

Bends with angular dimensions or shown on the Engineering drawings as 90° but not dimensioned, shall be $\pm 2^\circ$ in the unrestrained condition. This requirement shall apply to the outside of the bend and from the point of tangency.

NOTE: Flat metal bends with tolerance less than $\pm 2^\circ$ must be controlled by the specified tolerance. (Also, Manufacturing may control bends closer, based on end use or subsequent processing.)

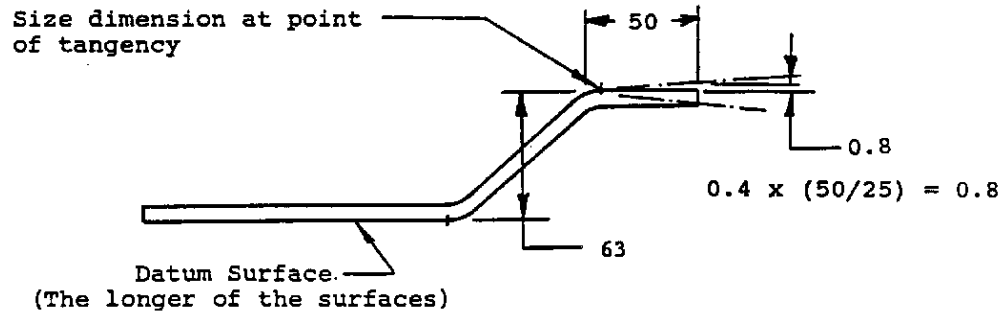


Because 110 mm dimension applies only at the point of tangency, there is no control implied to the rest of the vertical leg. Perpendicularity is controlled by the $\pm 2^\circ$ requirement and not by the size tolerance limits.

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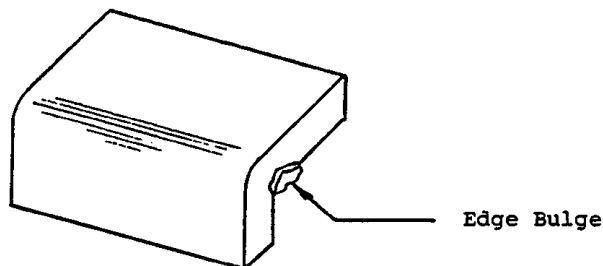
5.4.2 Parallel Surfaces

The deviation of two or more surfaces from a reference datum shall not exceed 0.4 mm per 25 mm of surface and must be within the stated drawing size at point of tangency.



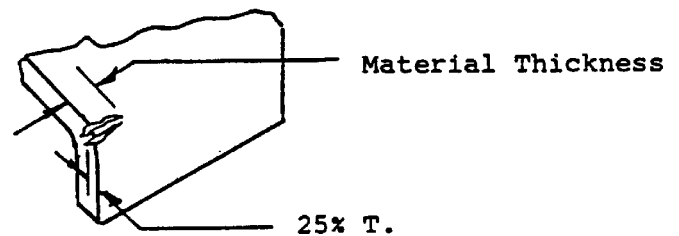
5.4.3 Bulges Due to Bending

The edge of a formed part will display a bulge at the end of the bend. Unless otherwise specified on the Engineering drawing, dimensions do not apply over the bulge.



5.4.4 Fractures

Surface fractures at the ends of a part and on the outside of a bend shall not exceed 25% (in depth) of the material thickness and 100% of the material thickness in length along the bend.

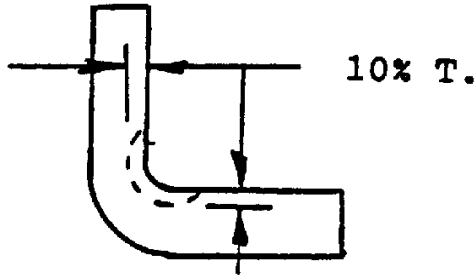


It is recommended that the burr side of the blank be on the inside of the bend (when possible) to minimize this condition.

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5.4.5 Corner Set

Corner sets shall not exceed 10% of the material thickness.

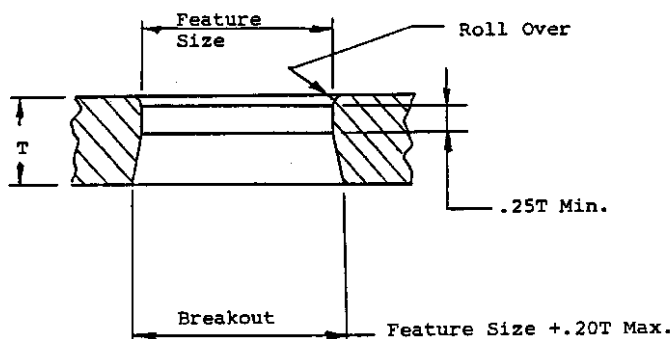


Sets may occur on both the inside and outside of the formed part provided the total material thickness reduction does not exceed 10%.

5.5 PUNCHED HOLES

5.5.1 Feature Size

The feature size of punched holes shall apply to 25 percent minimum of the nominal material thickness, unless otherwise specified on the Engineering drawing. Roll over is acceptable if the specified dimension for the feature size (length of depth) is maintained.

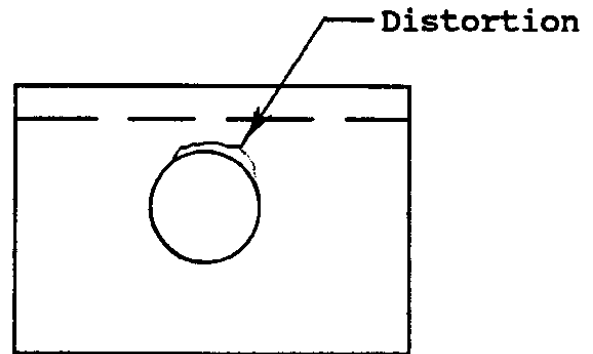


5.5.2 Breakout

The total breakout shall not exceed 20 percent of the material thickness.

5.5.3 Hole Distortion

Holes distorted by the flow of material in a forming or drawing operation are not acceptable if the hole tolerance limits have been exceeded.



5.6 BURR

5.6.1 Burr Removal Implied

When burr removal is not specified on the Engineering drawing, the following requirement shall apply. Burrs shall not exceed the value of 0.25 or 10% of the material thickness in height, whichever is greater.

5.6.1.1 Loose or hanging burrs must be removed.

5.6.1.2 Burrs that are hazardous or that may affect subsequent processing such as a weld fit-up or location in weld fixture, or weld quality (strength) must be controlled by Manufacturing.

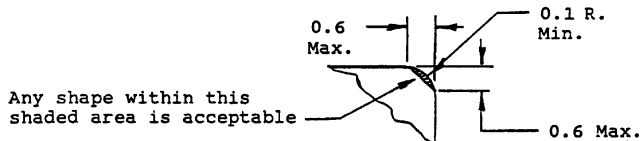
5.6.1.3 This requirement also applies to parts that are manufactured using plasma arc, laser, or flame cutting. Burrs and slag resulting from these processes must be controlled by Manufacturing.

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5.6.2 Burr Removal Specified

Where the Engineering drawing specifies: "NO BURRS" complete freedom of burrs is required as follows:

Edges—On edges of part, any non-hazardous configuration between 0.1 mm radius minimum and 0.6 mm maximum chamfer is acceptable.



If the "NO BURRS" specification is required only on specific edges, this requirement should be indicated on the drawing. (This standard does not apply to prints issued prior to April 1, 1983.)

NOTE: The creation of a sharp edge by deburring is not acceptable.

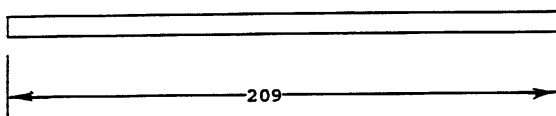


Unacceptable deburred conditions

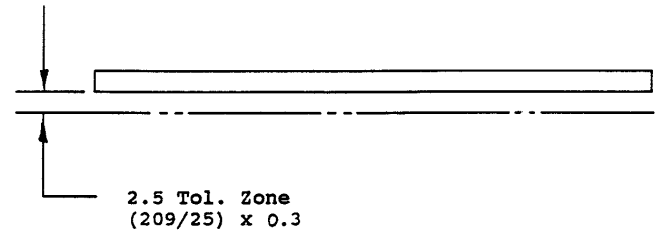
5.7 FLATNESS OF SHEET METAL PARTS

Surfaces shown flat on sheet metal parts shall be produced flat within 0.3 per 25 mm length.

5.7.1 Drawing Callout:



5.7.2 Interpretation:

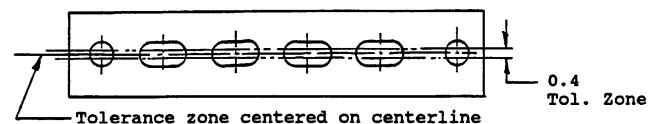


This surface must lie between two parallel planes 2.5 apart.

5.8 POSITION OF FEATURES ON A COMMON CENTERLINE

5.8.1 Features such as holes and slots shown on a common centerline shall be produced with a positional tolerance zone 0.4 wide.

Example 1:



NOTE: This requirement does not apply, in the free-state, to parts which are subsequently welded into an assembly. Camber (or straightness) of parts and/or centerlines must be controlled by Manufacturing for proper fit-up.

