



CONCEPT TO
COMPLETION

STANDARD MANUFACTURING GUIDELINES

This document is considered proprietary to MPE.

I. Engineering/Manufacturing Guidelines

A. MPE-INC drawing conventions

1. MPE uses English measurement units. Any customer prints received in metric will be converted to the English equivalent on the print as needed.
 - a. Convert by dividing dimensions in millimeters by 25.4 Example:
 $1330 \text{ mm} = (1330/25.4) = 52.362$
inches
 - b. English dimensions will be in 3 place decimals.
2. If Geometric Dimensioning and Tolerancing is used, especially on formed and welded parts, contact MPE Engineering to review datum selection and tolerances.
3. Engineering completes and retains Form 55350-007 Stage Gate Process Classification III for all customer owned designs.

B. Standard materials: MPE uses these materials when manufacturing parts unless otherwise specified by customer's request.

1. Cold Rolled Steel, ASTM A 1008, commercial steel
2. Hot Rolled Steel, ASTM A 1011 CS Type B commercial steel (pickled and oiled)
3. High Strength Low Allow, ASTM A 1011 HSLAS Grade 50/ Grade 80/ EX-TEN H50
4. Galvanized Steel, ASTM A 653 CS Type B G90 (MPE recommends pre-plated steel over zinc plating for cost considerations)
5. Aluminum 5052-H32, ASTM B 209
6. Stainless Steel 304, ASTM A 240, cold rolled, annealed, 2B finish

II. Punch Press/Laser

A. Maximum sheet dimensions for punch/laser

1. Punching 5' x 10' sheet
 - a. 7 GA. (.179") mild steel
 - b. .188" thick aluminum
2. Laser cutting 5' x 10' sheet
 - a. Up to .250" thick mild steel
 - b. .250" thick aluminum
3. Any thicker MPE will use the supply chain to procure flat blank of the part

B. General punch/laser tolerances

1. Feature to feature: $\pm .005''$
2. Edge to feature or edge: $\pm .005''$



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C. Special punches

1. Countersinks can be cold formed in the punch press to major diameter (+.020"/-.000") and angle. Through holes will vary more than a machined countersink.
2. Embossed features (dimples, louvers, card guides, etc.) involve displacement of material which will affect flatness, straightness, and surface finish of the part. The extent of the distortion will need to be verified upon prototyping.
 - a. Greatest height: .375"
 - b. Maximum material thickness: 14 GA. (.075"), maximum machine tonnage of 22 tons.
 - c. Maximum Length: 4"
3. Perforated patterns are available in many different patterns and densities.
 - a. They generally add distortion to a part and need to be evaluated upon prototyping.

D. Burrs and dross

1. Burrs or dross are unavoidable in the punching and laser cutting processes. They are formed on the side of the sheet metal where the punch or laser beam exits.
2. Laser dross will not exceed 10 percent of the material thickness. It should be confined to areas that will not be exposed to handling. Edges should be bent away from or protected from the user, otherwise a deburring operation must be added.
3. MPE will use an automated deburring machine or hand deburr to remove burrs or dross left on due to the punching and laser cutting operation, unless features prohibit.
 4. Punching burrs along the edges will not exceed 10% of the material thickness. Edges should be bent away from or protected from the user, otherwise a deburring operation must be added.
 5. Punch overlap marks will not exceed 5% of the material thickness. They occur because of the multiple hits it may take to punch an edge or feature of a part, called nibbling.
- E. Hold on tabs are required during CNC punching and laser cutting for holding parts in the sheet while they are being processed. They will be removed during the process unless otherwise stated on prints or MPE routings because of design considerations.

III. **Forming**

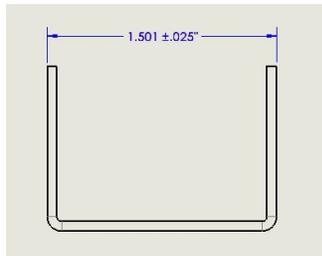
- A. General tolerances: MPE will be able to manufacture parts per prints with tolerances as shown below. Closer tolerances will require the use of special fixturing or tooling to achieve tighter tolerances, as specified during the quoting process.
 1. Feature to single bend: $\pm .015"$ (.38mm)



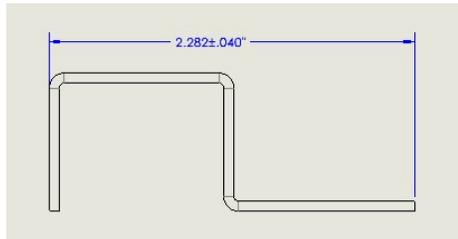
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2. Across (2) bends: $\pm .025"$ (.64mm)

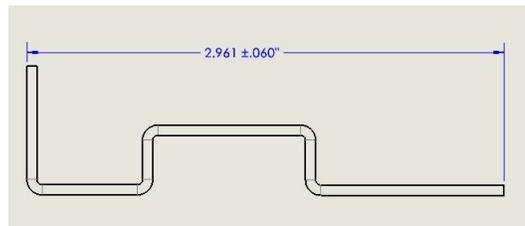


3. Across (3) to (4) bends: $\pm .040"$ (1.02mm)



4. Across (5) or more bends: $\pm .060"$ (1.52mm)

For parts with (5) or more bends, tolerances of bends may need to be reviewed with MPE because of gauging considerations.



5. Tolerances on bend angles will be $\pm 1^\circ$.

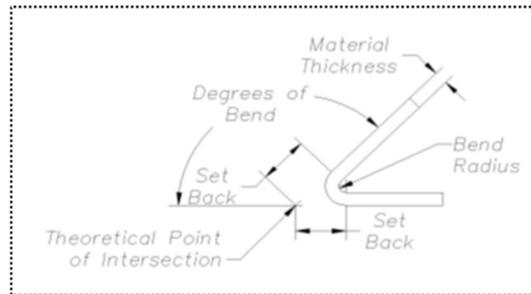
B. Standard bend radius: MPE will use the following standard bend radii when forming sheet metal parts, any other radii will be specials and will need custom made tooling for manufacturing.

2. All bend radii on manufactured parts will be material thickness unless otherwise specified on MPE or customer prints.
3. List of MPE standard press brake tooling
 - a. Recommended bend radius: material thickness



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- b. Every 1/32" increments up to 1/8"
 - c. Every 1/16" increments from 1/8" up to 3/8" Radius
4. Other radii are available upon request.
- B. Standard bend deductions
1. For bends other than 90° the following formula should be used to get bend allowance:
 - a. $((.01745 \times \text{radius}) + (.0078 \times \text{thickness})) \times \text{bend angle in degrees}$
 2. For bends other than 90° the following formula should be used to get the set back from the bend:
 - a. Outside: $(\text{radius} + \text{thickness}) \times \text{tangent}(\text{bend angle}/2)$
 - b. Inside: $\text{radius} \times \text{tangent}(\text{bend angle}/2)$



IV. Inserting

A. Insert types

1. PEM and Southco are MPE preferred hardware suppliers. All inserts are to be inserted per manufacturer's standard. Please see manufacturer's website for installation data:

www.pemnet.com

www.southco.com

2. MPE will utilize other hardware per customer's instructions.

B. The installation of captive hardware involves the displacement of material to enable fastener retention. The following must be considered:

1. Material thickness, insert location, and relationship to edges or bend radii.
2. Flatness and straightness, when a design calls for multiple inserts along any particular edge or feature.

V. Welding

- A. All welding shall meet all callouts on MPE or customer supplied prints and will be interpreted per the ANSI/AWS standard for sheet metal welding.
- B. The welds shall have thorough fusion, proper profiles, and no cracks. The under run, undercut, and porosity of the welds must conform to the standard.
- C. MPE can resistance spot weld (RSW) parts up to 12 ga. (.1046") thick steel or .090 aluminum. For thicker material it is recommended to MIG/TIG weld the parts.
- D. Parts will be welded together using custom made fixtures, tooling holes, or slots and tabs to hold them in correct locations.

E. General tolerances

1. All dimensions 25" and under: $\pm .040"$ (1.0mm)



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2. All dimensions over 25": $\pm.060$ " (1.52mm)
F. Design profile of parts may warrant different tolerance constraints.

I. Surface Preparation

All metal finishing shall meet MPE PRO-208 and form 55246-011 (MPE Cosmetic Specification) which will be specified on either the drawing or on MPE internal routings. Fastener witness lines to be visible unless otherwise specified.

II. Riveting

Where design considerations allow, MPE prefers and recommends the use of "Pop," "Briv," and "Geispa" style rivets for part fastening. In many instances superior part positioning can be achieved at a lower cost. See manufacturer's website for data:

www.emhart.com/products/pop.html
www.textronfasteningsystems.com/eng_tools_f/eng_tools_blind.html
<http://www.gesipausa.com/products/fastener/category/bn.html>

III. Powder Coating

A. Masking

- Standard masking dot diameters (stock items at MPE)
 $\frac{1}{4}$ ", $\frac{5}{16}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ ", $\frac{5}{8}$ ", $\frac{3}{4}$ ", 1", $1\frac{1}{4}$ "
- Standard masking tape widths (stock items at MPE)
 $\frac{1}{4}$ ", $\frac{3}{8}$ ", $\frac{1}{2}$ ", $\frac{3}{4}$ ", 1", $1\frac{1}{2}$ ", $1\frac{3}{4}$ ", 2"
- All internal threads and studs are masked as standard practice.

B. Powder coating

- MPE coats parts with epoxy, urethane, polyester, and hybrid thermo-set powder coatings.
- All parts are cleaned using a 5-stage in-line washer system.
- Powder coating cure temperatures are dependent on product and manufacturer. Refer to technical data sheet for the specific product. The entire mass of the part to be coated, must reach this temperature for proper cure.
- Colors can be matched per customer requirements.
- Insert witness line will be visible through powder-coat, unless otherwise specified
- Texture Classifications
 - Smooth
 - Textured: determined by formulation of the powder, not application method.
- MPE uses three grades for product appearance which are defined further in form 55246-011 (MPE Cosmetic Specification).
 - Grade A: A user contact surface or highly visible to the user in any use position.
 - Grade B: Usually visible though not normally directly facing the user while the product is in use.
 - Grade C: Usually hidden by other parts of the assembly or the inside surface of the assembly. Requires coverage for protection purposes only.

C. Silk-screening

- Silk-screening is done in-house at MPE.



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2. MPE can work with customer supplied artwork. Most file types can be accepted, and MPE can touch up files if required.
3. Multiple color silk-screens require multiple applications and screens.
4. Any colors can be matched upon request.

IV. **Assembly**

- A. MPE provides a wide range of assembly services including complete or sub-stage assembly and packaging of electro-mechanical products utilizing the following methods:
 1. Standard mechanical fastening with either unified or metric hardware
 2. Riveting (See section VII for more details)
 3. Electrical wiring and testing
 4. Routing of communication and other cables
 5. Kitting of related components
 6. Burn-in/run-in cycling
 7. EMI gasketing
 8. Sound absorption and/or thermal insulation
 9. Part serialization/lot code traceability.
- B. Assembly instructions
 1. MPE will document the assembly process to encompass both internal assembly instructions and customer validation requirements.
 2. These documents will be revision controlled and are part of MPE's manufacturing instructions.
- C. Packaging
 1. MPE will utilize customer designed/supplied packaging if available.
 2. MPE will coordinate design and testing (ISTA, FEDEX, UPS, etc.) of packaging per customer instructions.

V. **Quality**

- A. Certificates of Conformance to specifications are printed on the shipping papers for every shipment. Requirements beyond this can be provided upon request.
- B. MPE provides first article inspection reports for each new part or revision feature change of existing parts. Further sampling and documentation is available upon request.
- C. Operators perform first piece verification at each step of the manufacturing process.
- D. MPE provides raw material certifications upon request.
- E. MPE provides environmental compliance data (RoHs, REACH) upon request.
- F. If required, final inspection checklists can be provided with each part and/or can be stored electronically at MPE. Parts can be identified by serial number.

MPE-INC Quality Policy

MPE-INC is committed to Total Customer Care, compliance with requirements and to continually improve and maintain effectiveness of the Quality Management System.