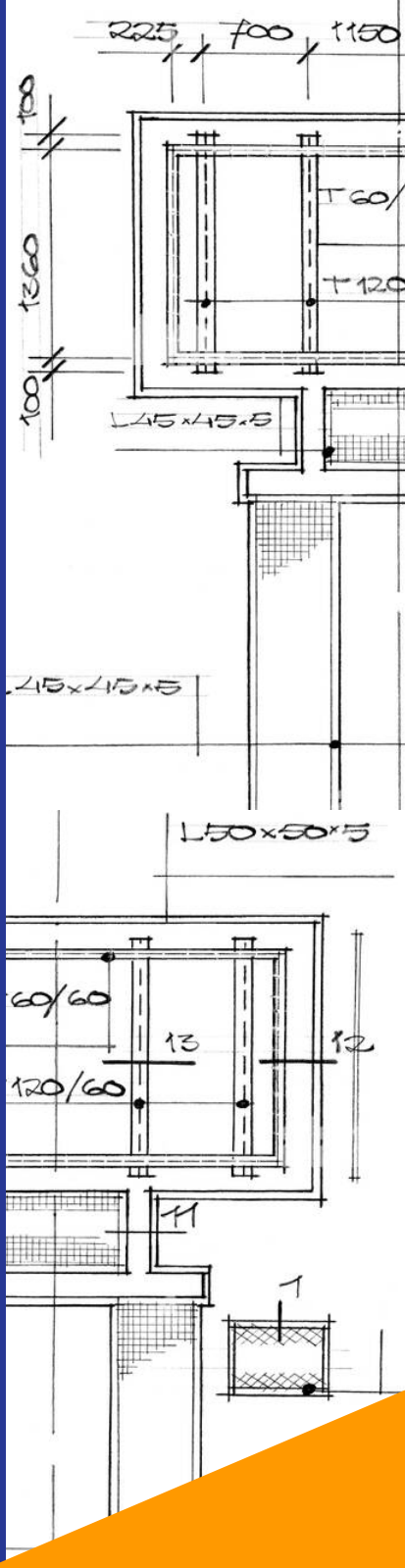
2024 DESIGN GUIDE

FOR ALUMINUM PERMANENT MOLD CASTING

batesville products, inc.



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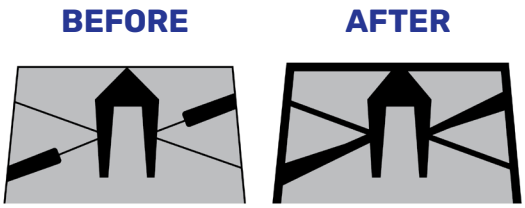
Wall Thickness

Wall thickness should be at least **0.180 inches**. Since permanent mold castings are gravity-fed and aluminum solidifies quickly, this ensure proper metal flow and solidification during casting.

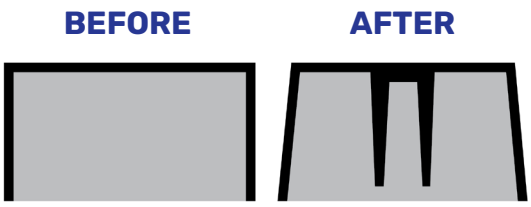
Avoid isolated thin or thick sections. These can negatively impact flow and solidification, causing shrinkage and other defects.

Need thinner walls or dramatic changes? Secondaries like machining and polishing can shave down excess material.



> 0.180 inches

Bosses



Use wall thickness & draft

Bosses aren't always needed, but sometimes designers add them to **position parts** for assembly or fixate two pieces together.

Remember:

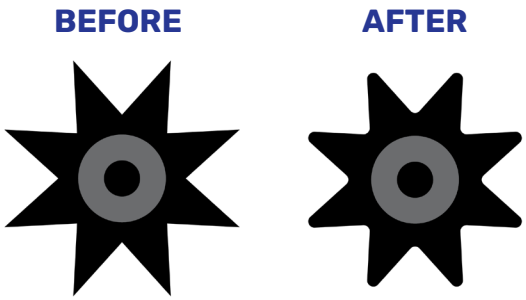
- Maintain uniform wall thickness
- Use draft & fillets
- If having trouble with metal flow, use ribs

Fillets & Radii

Slightly rounded corners make your part stronger! We recommend fillets & radii of **at least 0.030 inches**.

Sharp corners cause high stress, cracking, and tearing.

If your casting needs a 90-degree corner for assembly, consider secondary machining. This is a common practice in casting.



> 0.030 inches

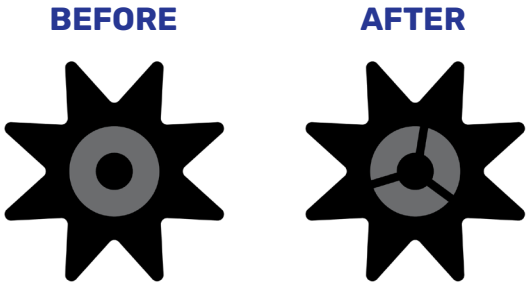
Ribs

Ribs and gussets make your casting **stronger** without adding excess thickness, weight, or material cost to your design.

Ribs and gussets also **help metal flow** into hard-to-fill features (like bosses).

Remember:

- Use an odd number in an offset pattern
- Only use when necessary. Don't add unnecessary complexity and cost to your casting.
- Use draft and fillets
- Walls should be thinner than primary walls, but thick enough for metal flow



Use odd number & offset patern

Draft

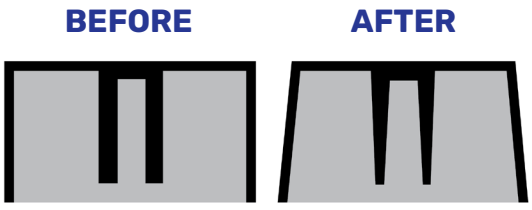
There's no such thing as too much draft in casting! Draft…

- Helps parts easily eject from the mold
- Extends mold life
- Creates flatter, straighter, higher-integrity parts with less distortion

Because draft is all about helping smoothly remove the part from the mold, draft should always move away from the parting line.

Minimum draft requirements depend on depth. Shorter walls require more draft than tall walls. Also, outside walls require slightly more draft than internal walls.

Length of Draw (in)	Minimum Draft
0.000 - 0.125	10°
0.126 - 0.500	7°
0.501 - 1.000	5°
1.001 – 5.000	3°
5.001 – 12.000	2°



Minimum depends on depth

Cored Holes

Holes and pockets can be designed into permanent mold castings. These are created by steel cores that are pulled in and out of the mold during casting.

Your hole design should include **draft** to ensure the steel cores can easily slide in and out of the casting. Cored hole draft requirements depend on diameter and depth.

After casting, cored holes can be fully machined to remove draft. Cored holes make machining quicker and easier! Alternatively, if your holes cannot have any draft, use sand cores to create holes and pockets.

Cored Hole Diameter (in)	Maximum Depth (in)	Draft
0.25	0.25	10°
0.5	1	7°
1	2	5°
2	4	3°
4	8	3°

Holes & Windows

Holes and windows can make manufacturing challenging because they often block metal flow.

For small holes and windows, **add bridges** that can be trimmed out later during machining. These bridges will help metal flow throughout the entire part.

For large windows, **add gates and risers** that can be cut out later.

Holes and windows should always have **more draft** than any other feature. Draft prevents tearing, binding, or twisting during ejection.

Ejector Pins

Ejectors pins, or knock out pins, are part of your permanent mold tooling. The pins help nudge the casting out of the mold. Each pin will leave a tiny ring mark on the surface of the casting that can be removed with machining or polishing.

The **number of pins, location, and size** depends on the size and complexity of the casting.

It's important to expect ejector pin marks on your permanent mold casting so you can set accurate **surface expectations and tolerances**. If you need a class A surface finish, note on your print that ejector pin marks should be polished out.

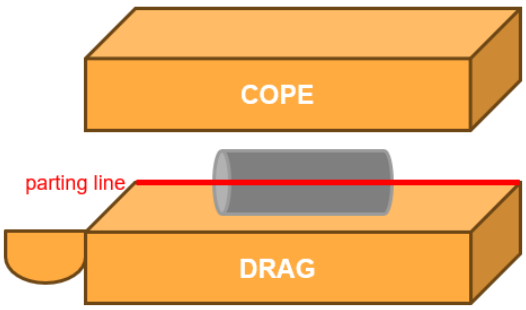
Projected Area (in^2)	Tolerance (in)
50	0.020
50 - 100	0.030
100 - 200	0.045

Parting Lines

The parting line is the **seam** where the cope *(top of the mold)* and drag *(bottom of the mold)* separate. The parting line can often be seen unless you remove it with a quick machining or polishing operation.

The parting line location **impacts your surface finish, metal flow, and tolerances.** Communicate your expectations with the supplier.

Features on the same side of the parting line can hold **tighter tolerances** than features split across the parting line. *(See linear and concentricity tolerances)*.



Flatness

The permanent mold flatness tolerance is **0.020 for the first 6 inches**. Add 0.002 for each additional inch.

Greatest Dimension (in)	Flatness Tolerance (in)
0 - 6	0.020
7	0.022
8	0.024
9	0.026

Linear Tolerance

The permanent mold as-cast linear tolerances **depend on parting line location**. Again, for tighter tolerances, design critical features on the same side of the mold rather than across the parting line.

Permanent mold has very tight linear tolerances in comparison to sand casting. Aluminum sand casting linear tolerances for features on the same side of the parting line start at 0.030 inches *(double that of permanent mold!)*.

If your design requires tolerances outside of these as-cast linear tolerances, you'll need to add a secondary machining operation.

ONE SIDE OF MOLD

Dimensions (in)	Tolerance
First Inch	0.015
Each Additional Inch	*Add 0.003*

ACROSS PARTING LINE

Projected Area (in^2)	Tolerance
0 - 10	0.010
10 - 50	0.015
50 - 100	0.020
100 - 250	0.025

Linear Tolerance: Cores

As-cast linear tolerances can vary when there is a sand core or metal core involved.

Sand cores are non-reusable inserts used to create hollow channels or passageways in the casting. This process is called semi-permanent mold. Unlike sand cores, **metal cores** are reusable, made of steel, and built into your mold.

Projected Area (in²)	Sand Core Linear Tolerance (in)	Metal Core Linear Tolerance (in)
0 - 10	0.015	0.010
10 - 50	0.025	0.015
50 - 100	0.030	0.015
100 - 250	0.040	0.022
250 - 1000	0.060	0.032

Concentricity

To hold very tight tolerances, we recommend designing complex and critical components to be on the same side of the parting line. The concentricity tolerance is **tighter for features on the same side of the mold than features across the mold.**

Permanent mold has very tight concentricity tolerances in comparison to sand casting. Aluminum sand casting concentricity tolerances for features on the same side of the mold start at 0.050 inches *(double that of permanent mold!)*.

ONE SIDE OF MOLD

Largest Surface Diameter (in)	Tolerance
0 - 5	0.025
Each Additional Inch	*Add 0.003*

ACROSS PARTING LINE

Projected Area (in²)	Tolerance
0 - 50	0.025
50 - 100	0.030
100 - 200	0.035
200 - 300	0.045

Machine Stock Allowance

Greatest Dimension (in)	Stock Allowance
0 - 6	0.045
6 - 12	0.060
12 - 18	0.075
18 - 24	0.090

PER SURFACE, NOT PER DIMENSION

For even tighter tolerances, you can add secondary machining. If machining, add **extra stock material**. Machine stock allowance ensures your final part dimensions are in spec.

Surface Finish

The average as-cast permanent mold surface finish is **200 to 420 RMS**. This is smoother than sand casting, but rougher than die casting.

However, permanent mold castings typically have **lower-porosity** than sand or die castings. This means you can easily machine or polish castings without the risk of opening up porosity and inclusion defects.

For an even smoother surface, consider **polishing or finishing**.

Readily available aluminum casting finishes include:

- Grit number finishes
- Satin
- Stainless steel shot blast
- Powder coating or painting
- Anodizing

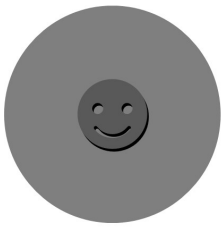
Cast Surface	RMS
Die	20 - 120
Investment	60 - 200
Permanent	200 - 420
Sand	300 - 560

Logos, Symbols, Letters

Permanently brand your product during the casting process with logos, symbols, and letters!

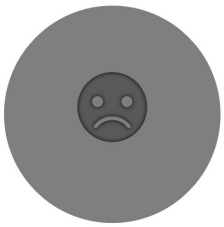
Use **raised symbols on a flat surface**. We do not recommend depressed symbols. Depressed symbols increase tooling cost and are more subject to mold wear and damage. If you prefer depressed symbols, we recommend instead creating a depressed section, then placing a raised symbol inside.

RAISED



USE

DEPRESSED



NOT USE

Feature	Minimum (in)
Size	0.156
Height	0.150
Face	0.015
Flank Angle	20°

Again, all standards presented are for permanent mold aluminum casting only. All tolerances are as-cast (not accounting for secondary machining or polishing).

If you have any questions for want a casting expert to look at your design, please contact **Batesville Products** at **812-537-2275** or visit **batesvilleproducts.com**. BPI has been engineering, casting, machining, inspecting, and polishing aluminum and zinc castings for over 75 years!