

CASTING PROCESS	DESCRIPTION	METALS	SIZE RANGE	TOLERANCES	AVERAGE TOOLING COST	RELATIVE COST FOR HIGH QTY	RELATIVE COST FOR LOW QTY	SURFACE FINISH	MINIMUM DRAFT REQUIRED	MINIMUM SECTION THICKNESS	EASE OF CASTING COMPLEX DESIGNS	EASE OF CHANGING DESIGN	COMMENTS
<b>GREEN SAND</b>	Process that mixes raw sand, clay and water, which is then compacted around a pattern to create a mold. Most common type of molding, suitable for any production volume, and typically a low-cost option.	Most Castable Metals	All sizes per foundry capabilities	0-3" = 0.03" per in. + 0.005" per in. for each additional in. Across parting line add 0.020" to small castings, 0.090" to large castings	Low	Low	Low	Ferrous: 420-900 RMS Aluminum: 175-350 RMS Copper Base: 300-560 RMS	1-5 degrees	Ferrous: 0.250-0.375" Non-Ferrous: 0.125-0.250"	Fair to Good	Best	Most widely used casting process for both small and large production runs.
<b>NO BAKE / AIRSET</b>	Molding method utilizing raw sand combined with resins and binder to create a hard mold capable of improved surface finishes. Excellent for lower-volume parts where superior dimensional stability is required.	Most Castable Metals	All sizes per foundry capabilities	0-3" = 0.03" per in. + 0.005" per in. for each additional in. Across parting line add 0.020" to small castings, 0.090" to large castings	Low	Low	Low	Ferrous: 420-900 RMS Aluminum: 175-350 RMS Copper Base: 300-560 RMS	3-5 degrees	Ferrous: 0.250-0.375" Non-Ferrous: 0.125-0.250"	Fair to Good	Best	Widely used casting process for both small and large production runs.
<b>SHELL</b>	Resin-coated sand, typically of a smaller grain size than green sand, which is applied to a heated pattern that activates the resin to create a hard-shell mold. Exceptional surface finishes can be achieved with reduced machine stock and/or draft.	Most Castable Metals	Typical max mold area = 3000 in <sup>2</sup>	Ferrous: +/-0.008" per in. up to 3" add 0.003" per in. over 3" Non-Ferrous: Add 0.005-0.010" per in. across parting lines, under 1" = +/-0.004" 1-3" = +/-0.010" 3-6" = +/-0.013" 6-12" = +/-0.016" 12-20" = +/-0.020"	Medium	Medium	Medium	Ferrous: 200-350 RMS Aluminum: 75-150 RMS Copper Base: 150-200 RMS	0.5-2 degrees	Ferrous: 0.125" Non-Ferrous: 0.080"	Good	Fair	Used for production of fairly small parts for which closer tolerances and improved surface finishes are required than are obtainable from sand castings. Widely used in core production.
<b>INVESTMENT</b>	Casting process in which wax replicas are coated with a slurry mix of ceramic refractory and sand, allowed to dry, and then heated to extract the wax, leaving behind a near-net-shape cavity. Capable of creating shapes that are not possible by any other molding method, particularly for small or intricate components. Widely used to eliminate additional machining expense.	Most Castable Metals	0.1 to 100 lbs	+/-0.005" per in. up to 3" add 0.002" per in. over 3"	Medium	High	Medium	60-120 RMS	0-1 degrees	Carbon Steel: 0.090" Stainless Steel: 0.125" Aluminum: 0.030" Copper Base: 0.030"	Best	Fair	Used for precision castings, particularly for complex designs.
<b>LOST FOAM</b>	Can be utilized in two different methods; The first method is similar to investment, in which a polystyrene replica is coated with ceramic refractory and then molded in sand. The second method consists of foam patterns that are molded into a media similar to no bake or airset. In either method, molten metal is poured directly into the sand mold and evaporates the foam during the casting process, creating a part with no draft or parting lines.	Most Castable Metals	Up to several hundred pounds	0-3" = 0.03" per in. + 0.005" per in. for each additional in. Across parting line add 0.020" to small castings, 0.090" to large castings	Low	High	Low	Per type of foam used	None	Ferrous: 0.250-0.375" Non-Ferrous: 0.125-0.250"	Good	Good	Widely used for prototypes and low usage parts. In some cases patterns can be used more than once.
<b>PERMANENT MOLD</b>	Reusable metal tooling that can be used to create repeatable dimensional accuracy, typically used for decorative or ornamental products made from nonferrous materials.	Aluminum & Copper Base	All sizes per foundry capabilities; Aluminum = 0.5 to 100 lbs.	Aluminum: +/-0.015" per in. up to 1" add 0.002" per in. over 1" Across parting line add 0.010" to small castings, 0.030" to large castings	Medium	Medium	High	Aluminum: 125-200 RMS Copper Base: 175-225 RMS	Ferrous: 3-5 degrees Aluminum: 2-4 degrees Copper Base: 3-5 degrees	Ferrous: 0.187-0.250" Aluminum: 0.100-0.150" Copper Base: 0.100-0.150"	Fair	Poor	Used for moderate quantities of semi-precision castings. Normally less expensive than sand casting for 100's - 1000's of parts. Limited applicability for ferrous metals.
<b>DIE CAST</b>	Method in which molten metal is forced into a metal die under pressure. This process is suitable for repeatability of medium- to high-volume, intricate or close-tolerance parts.	Aluminum, Zinc, Magnesium, & Copper Base	Typical max mold area = 3 ft <sup>2</sup>	0.0015" per in. Not less than 0.002" on any one dimension. Across parting line add 0.010"	High	Low	High	20-90 RMS	Aluminum: 1-3 degrees Zinc & Mag: 0.5-2 degrees	Aluminum: 0.050" Small 0.080" Med Zinc & Mag.: 0.025" Small 0.040" Med	Good	Poorest	Very widely used for high production of aluminum and zinc castings. An inexpensive way of obtaining precision parts.
<b>CENTRIFUGAL</b>	Process utilizing permanent tooling that is rotated horizontally or vertically while molten metal is introduced, typically used to manufacture pipe or other cylindrical products.	Most Castable Metals	OD 2 to 50 in; Length & wall thickness per foundry capabilities	OD = 0.1" Small Dia ID = 0.03-0.06"	None	Low	Medium	250-500 RMS	None	Per foundry capabilities	Not Practical	Good	Used for round tubular or cylindrical castings. ID will likely require machining due to impurities. Excellent casting soundness.
<b>V-PROCESS</b>	Dry sand molding method that uses a vacuum to hold a membrane on the surface of the pattern, which is then backfilled with sand. Advantages are exceptional surface finish and tighter dimensional control than most conventional sand casting processes.	Most Castable Metals	All sizes per foundry capabilities	+/-0.010" per in. up to 1" add 0.002" per in. over 1" Across parting line add 0.020" max	Medium	Medium	High	125-250 RMS	None	0.090-0.125"	Good	Good	Unlimited pattern life. Used for medium to high volumes.