BECKER
METAL WORKS, INC.
INVESTMENT CASTINGS

QUALITY INVESTMENT CASTINGS DELIVERED QUICKLY

Becker Metal Works was originally incorporated in 1986 to provide stainless steel investment castings for the medical industry. Since that time, we have expanded to service the energy, machine tool, food processing, chemical and defense industries, to name a few.

At Becker Metal Works we offer our customers more than just high quality investment castings; we strive to offer complete customer satisfaction during every step of the process and hope to provide you with a product that will meet or exceed your expectations for quality and delivery. Our representatives will work with you to determine the best possible manufacturing method for your part, whether that's an investment casting from our foundry or another process. We will help you determine the proper alloy selection, secondary operations and testing procedures to design a part that offers the integrity you require and reduces the need for secondary machining so you can achieve the lowest possible overall cost. From start to finish, the customer is the focal point of our business.

WHY CHOOSE BECKER METAL WORKS?

- Short lead times.* 4-6 weeks for tooling/samples and 6-8 weeks for final delivery.
- We specialize in producing internal configurations that are not possible with other processes.
- We are capable of producing castings ranging from a fraction of an ounce all the way up to 80 lbs.
- We offer stocking programs that allow our customers to receive their castings only when needed, thus eliminating the need to carry an inventory.
- Our customers commonly experience cost savings of 50% or more.

** Lead times may vary depending on part complexity.*

BENEFITS OF INVESTMENT CASTING

- **Investment castings are precise, repeatable and predictable.**
- **Almost any assembly can be produced as a one-piece configuration, which is inherently strong in all directions.**
- **The overall weight of many parts can be significantly reduced.**
- **Investment casting can eliminate the need for draft angles.**
- **Metal composition can be changed or modified at any time.**
- **Many part features which are especially difficult to machine, such as cams, grooves, bosses, holes and slots, can be readily produced.**
- **Investment castings commonly achieve surface finishes of 125 RMS.**
- **Producing parts to net or near net shapes can reduce or eliminate machining.**
- **Reducing the amount of machine operations allows you to upgrade materials to attain stronger parts.**

INVESTMENT CASTINGS

The term "investment" refers to the ceramic materials that are used to build a hollow shell into which molten metal is poured to form the casting. The origin of the term investment comes from the solid mold process where a plaster-type material is poured or "invested" into a container that holds a clustered tree of small plastic patterns that are identical to the casting being produced. After the investment material has set, the disposable patterns are burned out leaving a hollow cavity into which the metal is poured.

COST SAVINGS

Cost savings of 50% or more are common with castings versus other manufacturing processes. Since the investment casting process can produce parts which achieve or closely approximate finished dimensions, you can enjoy significant savings through elimination of machining operations, increased tool life and reduction of labor cost and parts scrap rate. When dealing with expensive alloys, you don't want waste in the form of metal chips, shavings or cut off pieces. With investment castings "you get what you pour."

The investment casting process can also provide you with the possibility of producing your parts in a one-piece configuration, which might have previously required several pieces made in different processes and materials.

QUALITY

If consistency has ever been a problem with other processes, investment casting is consistent from run to run within casting tolerance. Don't worry about tooling wear, changes in dimensions, or other problems associated with alternate processes. With investment casting tooling you get the same dimensions next month, next year and up to ten years from now.

CASTING & SECONDARY MACHINING

The investment casting process offers you new configuration possibilities for your parts, as well as the ability to produce them to net or near net shapes. These features will benefit your manufacturing process by requiring the machining of critical areas only. This ultimately reduces the amount of machine operations, thereby reducing machine time and perishable tool cost.

We understand that our products are literally your products. Our success depends on making those products work successfully for you every time and in every way. It is our goal to provide you with complete satisfaction through our commitments to quality and customer service.

THE CASTING PROCESS

WAX INJECTION

The investment casting process begins with the production of heat-disposable wax patterns. The patterns are made by injecting wax into a metal mold. These disposable patterns are the same as the finished part, but with allowances made for shrinkage.

PATTERN ASSEMBLY

Each wax pattern carries a gate. The gate has three basic functions:

1. To attach patterns to a tree, forming a cluster.
2. To provide a channel for draining wax from the cluster.
3. To provide a channel through which the molten metal will enter and feed the casting. The wax patterns are fastened by the gate to runners, which attach to a pouring cup. The patterns, sprue and pouring cup form the cluster (commonly known as a tree), which is needed to produce the ceramic mold.

THE SHELL PROCESS

Our ceramic shell mold technique utilizes a robotic system that dips the entire cluster into a ceramic slurry, drains it, and then coats it with fine ceramic sand. After drying (in a humidity and temperature controlled environment), this process is repeated again and again using progressively coarser grades of ceramic material until a self supporting shell can be formed.

PROCESS COMPARISONS

Process	Metal Options	Design Freedom	Volume Capability	Tolerance Control	Size Range
Investment Cast	Most	Most	All	Average	Average
Die Cast	Few	Least	High	Average	Average
Forging	Average	Least	High	Poor	Average
Permanent Mold	Average	Average	All	Average	Average
Plaster Mold	Few	Average	Low	Average	Average
Powder Metal	Average	Least	High	Best	Small
Resin Shell Mold	Average	Average	All	Average	Average
Sand Cast	Most	Average	All	Poor	Large

* While initial costs can be higher, a lower overall cost can be achieved.

DEWAX

The ceramic shell is placed in a high temperature steam autoclave to remove the wax from the shell. This will leave a ceramic shell containing cavities of the desired casting shape along with the designed running and feeding system.

CASTING

The ceramic shell is fired to burn out the last traces of wax while developing the high temperature bond of the ceramic system. Firing the shell also preheats the mold in preparation for casting. Once preheated, the molten metal is poured.

CLEANUP

After the poured molds have been cooled, the mold material is removed from the cluster. This is done by mechanical vibration and chemical cleaning. Individual castings are then removed from the cluster by means of friction saws and cut-off wheels. Any remaining protrusions left by the gates are removed by gate grinding.

The castings are now ready for any secondary operations such as heat treating, straightening or machining.

Surface Finish	Wall Minimum	Normal Delivery	Draft Required	Tooling Cost	Unit Cost
Average	Average	Average	No	Average	High*
Best	Average	Long	Yes	High	Low
Poor	Large	Long	Yes	High	Average
Average	Large	Average	Yes	Average	Average
Average	Large	Short	Yes	Low	High
Best	Smallest	Average	No	Average	Low
Poor	Large	Average	Yes	Average	Average
Poor	Large	Short	Yes	Low	Average

QUICK FACTS

GENERAL TOLERANCES

Tolerance is defined as the amount of allowable deviation. The use of tolerances will normally reduce the need for secondary operations, helping to keep costs to a minimum.

Inches		Millimeters	
Dimensions	Tolerances	Dimensions	Tolerances
Up to 1.000	±0.005	Up to 25.40	±0.127
Up to 2.000	±0.010	Up to 50.80	±0.254
Up to 3.000	±0.015	Up to 76.20	±0.381
Up to 4.000	±0.020	Up to 101.60	±0.508
Up to 5.000	±0.022	Up to 127.00	±0.559

Tolerances applied linearly ± .005 in/in

STRAIGHTNESS

Straightness is the deviation of the cast axis from the true axis. If one side of a casting is concave and the other side is convex, the casting would be out of straight.

WALL THICKNESS

Wall thickness is dependent upon size, configuration and alloy choice. Minimum wall thickness: 1/16"

SURFACE TEXTURE

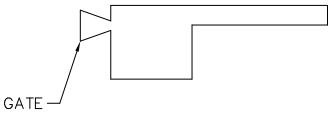
Minimum surface texture: 125 RMS

SIZE & WEIGHT

- 16" Maximum diameter
- 22" Maximum length
- ¼ oz. to 80 lbs.

GATING

A gate is the channel through which the molten metal enters the part.



FLATNESS

Flatness tolerances can only be generally supplied, as it varies with configuration and alloy used.

COCENTRICITY

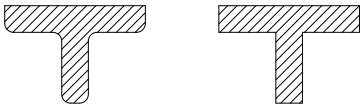
Cocentricity is defined as two cylindrical surfaces sharing a common point or axis as their center.

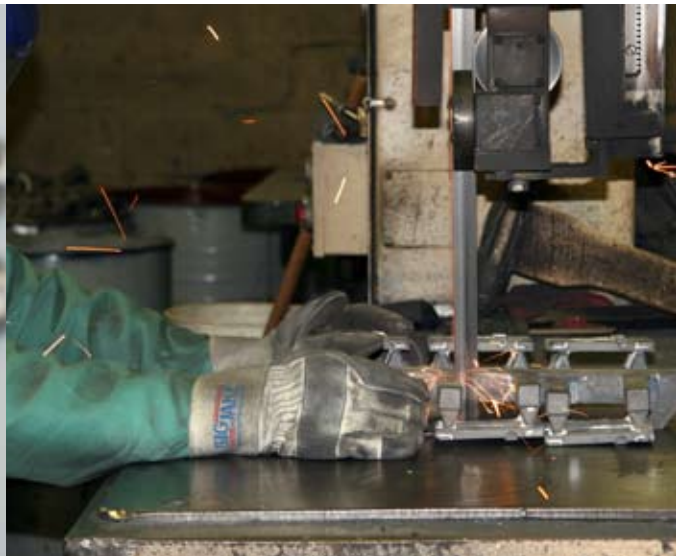
(TIR)=(.010)(O.D. – I.D.)(Length)

Minimum Tolerance for Cocentricity: .005"

FILLETS & RADII

Sharp corners and intersections can lead to unsound conditions and poor structural characteristics. As a general rule, the radius should be one-third to one-half the section thickness. Fillets and radii can be automatically configured into the design of your part to help increase its strength and reduce your machining and tooling costs.





FREQUENTLY ASKED QUESTIONS ABOUT INVESTMENT CASTINGS

1. **WHAT ALLOYS CAN BE POURED AS AN INVESTMENT CASTING?** Generally all ferrous and non-ferrous materials can be investment cast. On the ferrous side, carbon, tool and alloy steel along with the 300, 400, 15-5PH and 17-4PH stainless steels are most commonly poured. Most aluminum, copper base, and other non-ferrous materials can be cast. In addition, these are the "exotic" alloys used primarily in the aircraft engine industry to produce blades and vanes. These alloys are primarily composed of nickel and cobalt with a variety of secondary elements added to achieve specific strength, corrosion and temperature resistant properties.

2. **WHAT SIZE RANGE OF PARTS CAN BE PRODUCED BY THE INVESTMENT CASTING PROCESS?** Investment castings can be produced in all alloys from a fraction of an ounce (such as a dental brace for a tooth) to over 1,000 pounds (complex aircraft engine parts). Of the approximately three hundred investment casting foundries nationwide, most cast parts in the ounces to 20 pound range. Presently, a larger number of foundries are increasing their capacity to pour larger parts and pieces between 20-120 pounds. Becker Metal Works produces parts in the ¼ ounce to 80 pound range.

3. **WHAT ARE THE "AS CAST" DIMENSIONAL TOLERANCES I CAN EXPECT?** Typically, a linear tolerance of ± .005 in/in is standard for an investment casting, however this can vary depending on the size and complexity of the part. Subsequent straightening or coining procedures often enable even tighter tolerances to be held on one or two specific dimensions. A concerted initial effort between the customer's and the foundry's engineering staffs can often result in an investment casting that substantially reduces, or completely eliminates the previous machining requirements to produce an acceptable part.

4. **WHAT TYPE OF SURFACE FINISH CAN I EXPECT FROM AN INVESTMENT CASTING?** Because the ceramic shell is built around smooth patterns produced by injecting wax into a polished metal mold, the resultant casting finish is excellent. 125 microfinish (RMS) is standard and even finer finishes (63 or 32 RMS) are not uncommon on aircraft engine castings. Each foundry has its own standard for surface blemishes (positives, negatives). These are discussed and agreed upon with the customer based on the function and cosmetic requirements of the part prior to the release of the tooling order.

5. **AREN'T INVESTMENT CASTINGS EXPENSIVE? AND IF SO, HOW CAN THEY SAVE ME MONEY?** While investment castings can be more expensive than forged parts, or those produced by other casting methods, they make up for the higher cost through the reduction of machining achieved by the near net shape that can be held as cast. Many parts that require milling, turning, drilling and grinding to finish can be investment cast with only .020 - .030 finish stock. Again, it is imperative for the engineering staff of the foundry and customer to get together and discuss what can or cannot be cast to determine final finishing requirements and the potential cost savings.

6. **HOW MANY PIECES DO I NEED TO MAKE BUYING AN INVESTMENT CASTING PRACTICAL?** Not as many as you would think! Tooling amortization is a key factor in determining whether or not an investment casting is practical. The machine tool industry will often specify an investment casting on as few as 25 pieces of a new part with only occasional replacement parts being ordered. Conversely, some foundries produce quantities exceeding 100,000 parts per month, which are largely for automotive use. The bulk of investment castings produced fall into the 100-10,000 piece annual range.

7. **WHAT TYPE OF TOOLING OR PATTERN EQUIPMENT IS NECESSARY?** Typically, a split cavity metal mold is manufactured that is the "female" mold from which the "male" wax patterns are produced. Depending on the complexity of the casting, various combinations of aluminum, ceramic or soluble cores may be employed to yield the desired configuration. Most tooling for investment castings fall in the $1,000 - $10,000 category.

8. **WHAT ABOUT THE INTEGRITY OF AN INVESTMENT CASTING? WILL I HAVE PROBLEMS WITH POROSITY AND SHRINKAGE THAT IS USUALLY NONEXISTENT IN BAR STOCK AND FORGINGS?** Investment castings are used for many critical applications that require the parts to be x-rayed and meet definite soundness criteria. The integrity of an investment casting can be far superior to parts produced by other methods.

9. **WHAT ARE THE LEAD TIMES I CAN EXPECT WHEN ORDERING AN INVESTMENT CASTING?** Nothing varies more than lead times depending on part complexity and foundry capacity. Generally 4-6 weeks is typical for tooling and sample castings and 8 weeks for production.

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