

# Prepare to Powder Coat and Put Off the White Stuff

Six preliminary steps can help fight off long  
And short-term corrosion.

By Jon P. McGraw  
Alloy Casting Co.

This article originally printed in the 2002 July-August issue of Fabricator Magazine, an official publication of the National Ornamental & Miscellaneous Metals Association.

**P**owder coating aluminum castings can sometimes be a problem. Immediate problems appear when the powder coat bubbles because of gas evolution from the casting during the heating cycle. Long-term problems happen when white corrosion develops under the coating, and flaking and peeling starts. Even though powder coating is a sophisticated process, these two problems do occur. Fighting off their occurrence is possible by taking correct preliminary steps. Preventative action can mean the use of a better base metal, preheating to degas the casting, extensive chemical cleaning, proper acidic etching rinsing with deionized water, and adequate powder curing. A lack of attention to any one of these steps can mean a rough surface and/or a coating that eventually will flake.

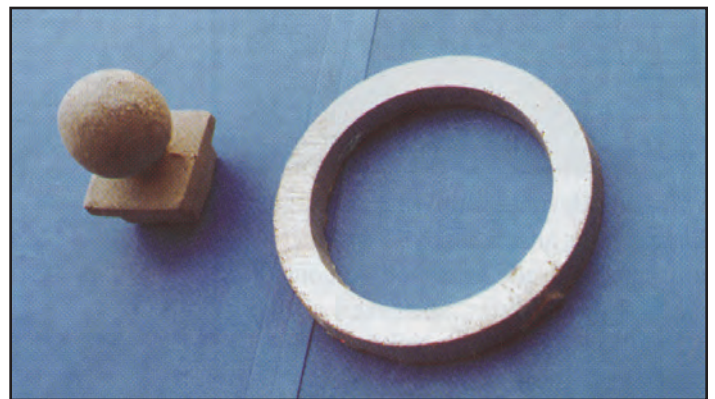
## One: Use a Better Base Metal

When most aluminum castings are placed in a seacoast environment they demonstrate white corrosion. This corrosion is caused by salt air penetrating the coating and allowing a galvanic battery action between the aluminum and the dissimilar metals in the aluminum. These dissimilar metals are mainly copper

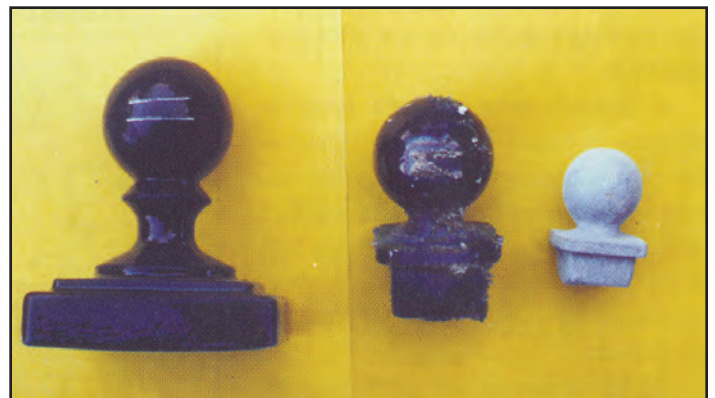
### FYI IN THIS ARTICLE . . .

- An industry supplier of aluminum castings and aluminum hardware lists six ways to avoid two problems that occur when powder coating aluminum
- Short term problem, like bubbling, result from gas evolution during the heat cycle.
- Long term problems, like flaking and peeling, stem from white corrosion setting in between the coating and the base metal.

For more info call Jon McGraw at (800) 527-1318



*In the above example, the ball cap with the dull white corrosion was made with a standard aluminum casting alloy. The ring shown was made with a marine-grade alloy and shows no corrosion. It has retained its metallic shiny surface. Both samples were placed together in a chlorine corrosive environment.*



*These samples were placed in a severe chlorine atmosphere to replicate a corrosive environment. The sample on the right is a typical casting showing a white-chalky surface. The center powder coated sample shows corrosion that has penetrated from the inside out of a typical casting. The marine-grade ball aluminum cap on the left shows no corrosion. Even with two saw cuts that were put through the coating and into the ball prior to the corrosive environment, the marine-grade metal did not corrode under the powder coat nor did the coating flake off*



*Left: Dissimilar metals in almost any form can cause severe corrosion. The green area shows severe galvanic corrosion caused by a marine-grade aluminum ball cap attached to a stainless steel bolt.*

*Right: This ball plug was made with a standard casting alloy, degassed and double coated. The ball exhibits few bubbles but even the double powder coating did not prevent corrosion from penetrating where the coating had been thinly applied. Green speckles show corrosion penetration.*



and zinc. The cause of the problem can be eliminated by using a marine-grade aluminum alloy having magnesium as a major component. Even under the most severe conditions, the marine-grade alloy stays shiny and coherent under the powder coat and eliminates white corrosion.

## **Two: Degas the Metal**

The second step for excellent powder coating of aluminum castings is to run a preheat cycle to degas the metal. The preheating expels the contained hydrogen that was entrapped as a natural result of the casting process. Aluminum sand mold castings are made in a mixture of sand, clay and approximately 4 percent water. The impact of the molten aluminum on the damp sand creates steam of which a portion is absorbed into the casting as hydrogen. During the powder coat heating cycle, the hydrogen is expelled and shows up as a bubbly surface. This problem can be eliminated by first using a preheat cycle that is 50% to 100% higher than the normal powder curing temperature and for a time cycle 30 to 100 percent as long as the powder curing time. A good degassing cycle will eliminate unsightly bubbles.

The proper selection of a marine-grade alloy and degassing can greatly reduce problems with powder coating on aluminum castings. But even with those actions, there are two more essential steps that need to be taken: good cleaning and good surface etching.

## **Three and Four: Cleaning and Etching**

Good cleaning entails alkaline decontaminating to remove organic oils, waxes and lubricants, and acidic cleaners to remove inorganic rust, scale, weld-

ing smut and to etch the surface. Contaminates and moisture left on the surface will detract from powder adhesion and give a poor coating life.

## **Five: Deionized Water Rinsing**

After acidic etching the surface must be rinsed to remove contaminants and rinsed sufficiently to give a “water breakfree” cascade off the surface. Deionized water is the best media for this procedure.

After rinsing, the casting should be dried and free of powder or streaking on the surface. A powdery film indicates poor rinsing or old, heavily contaminated cleaning fluids.

## **Six: Curing**

Proper curing of the powder coat is also critical for good longevity. A weak, soft coating will not stand up to the elements. As indicated above it takes several correct steps to enhance the life of powder coating. A misstep in any one can cause flaking.

I have seen castings on a gate application where the coating on cast aluminum spear finials was in excellent shape but only 24 inches lower on the same picket the cast aluminum collars were badly corroded with the powder coat flaking off. It was difficult to determine which of the many initial steps had been adequate for the finial but inadequate for the collar. Note the photographs on this page showing actual job applications where the powder coat process proved to be inadequate.

Other reports from the field suggest that imported aluminum castings exhibit much more out-gassing and corrosion than domestic castings. This is probably due to higher levels of dissimilar metals and

contaminates and lower quality foundry practices at foreign shops.

The important steps for powder coating are the same important steps for other coatings as well, be that fluoropolymers, wet paints, or hybrid combinations.

A good powder coating system is a sophisticated process. There are many sequential steps that must happen correctly in order to obtain good results. These detailed steps are highly technical and more than can be covered in this short article. So the next time you send a job with aluminum castings “out to be powder coated” and worry about the results, think of the many steps that are essential to providing a smooth, long lasting coating. Reduce those worries and insure good results by taking preventative action. Make sure the job is not returned.

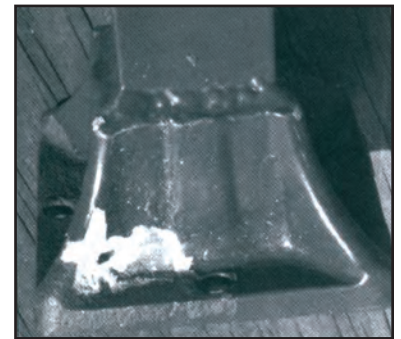
---

---

---



*Below and right: White corrosion has deteriorated the powder coating on the floor flange below and on the metal rings of this cast iron gate.*



# The survey says, . . .



These spear points illustrate the coherent coating of marine grade castings in excellent condition after one year on the beach.

## “Marine grade castings!”

■ A pictorial survey of eight case studies suggests that using marine grade castings and a modified powder coating application to avoid degassing results in long lasting beautiful aluminum castings, even in harsh salt water environments.

*By Jon McGraw  
Alloy Casting Co. Inc.*

*There are many steps necessary* to providing a good, hard, coherent coating to aluminum castings. These steps include proper cleaning and rinsing, degassing, and proper curing of the coating. However, even if these steps are followed and the powder coater does the best possible job, sufficient evidence from on-site inspections and field reports suggests that another step is necessary on your part: using marine grade base material. The marine grade approach offers added pro-

tection that makes your job look better for a longer period of time. And that reduces call backs, which makes all of us happier.

The rapid flaking and peeling of coatings from aluminum castings in a severe weather environment or the normal long term slow deterioration in a mild environment can be resisted with the proper selection of marine grade base metal because marine grade aluminum castings resist corrosion and improve coating performance.

### For your information

**Poor finish:** Non-marine grade castings and sub-par powder coating application (page 30).

**Better finish:** Marine grade castings and sub-par powder coating application (page 32).

**Best finish:** Marine grade castings and good powder coating application including a modified degassing pre-bake cycle (page 34).

**Contact:** Jon McGraw, Alloy Casting Co. Inc., Ph: (800) 527-1318.



**This scroll casting is not marine grade. It shows severe white corrosion after only 18 months in its ocean environment in Sarasota, FL. No coating remains.**



**This 12-year-old aluminum furniture in Dallas, TX, is also not marine grade. Even though it is not in a harsh marine environment, its powder coat is peeling and corrosion appears.**

### **Corrosion on aluminum**

Flaking and peeling occur on regular aluminum because air penetrates through the coating and corrodes the base metal. The devastation of the coating can occur rapidly when the job site is next to the ocean. Or it can take a much longer period of time in a more temperate climate. Either way, however, the castings will eventually show signs of corrosion. The scroll casting pictured at the top of this page has been on the ocean only 18 months and shows



**This 2" ball cap is not marine grade. It shows chalk corrosion and flaking (starting at corners) after four years on the Indian River in Vero Beach, FL.**

almost complete disintegration; whereas the aluminum furniture (pictured below it, bottom of page 29) is located in the more moderate environment of Dallas, TX. In this less harsh environment the aluminum held off significant corrosion for 10 years. The furniture has now been in the weather 12 years.

### **Poor: Corrosion on non-marine grade castings with sub-par powder coating application**

Typical corrosion of non-marine aluminum castings is shown at left. The ball cap has been near the ocean for four years and shows the corrosion on the corner edges where only a thin layer of coating might have been applied. This edge with a thin coating enables the salt air to penetrate here first and begin the corrosion peeling action. The root cause of the white chalk aluminum corrosion is the residual amounts of copper that create a galvanic reaction with the aluminum base material.

### **Better: Corrosion on marine grade casting with poor powder coating application**

Even the use of virgin metal with the correct marine grade chemistry, however, cannot cure the faults of a poor coating application. Pictured at the top of page 32 is a handrail installed near the ocean in Palm Beach, FL. For eight years the castings have been directly exposed to the wind and spray of the ocean. However, they are still shiny and coherent. This shiny and coherent surface indicates no galvanic corrosion has occurred as the marine metal has successfully resisted the salt air. But because of the



**This flower panel in West Palm Beach, FL, shows flaking because of a poor coating job. But its marine grade castings are still shiny and coherent after eight years.**

poor powder coating application, the net effect is still a poor looking rail. Compare this picture at left with the non-marine grade aluminum castings that have been on the ocean only 18 months (top of page 29). Marine grade castings on the ocean eight years with no corrosion pictured at left show the value of the proper base metal. Again, however, even the marine grade metal could do nothing to improve the original poor powder coating.

**Best: Corrosion on marine grade castings with good coating application**

A recent on-site survey of many copper-free marine grade castings that have been on the ocean between one and 3½ years shows the excellent results of combining marine grade castings with good powder coating applications. Shown below and on page 34, the castings are coherent and show no signs of corrosion or flaking.

When I visited one fabricator in Jupiter, FL and asked to visit job sites that have had marine grade metal for



**This aluminum rail with marine grade aluminum cast collars also shows a coherent coating in excellent condition after three years on Florida's Intracoastal Waterway.**



This marine grade and well powder coated spear and ball cap located just 100 yards from the ocean is in excellent, coherent condition after 3 1/2 years.



This marine grade large, heavy seashell aluminum casting adorning an exterior fence located between the Intracoastal Waterway and the Atlantic ocean shows a coherent coating in excellent condition after two years.

several years, he said, "I don't know where they are. I only know I have had no call backs because of poor performance."

#### **Caution: Avoid out gassing during the powder coat cycle when using marine grade castings**

The above comment shows the overall value of using marine grade aluminum. However, the value of marine grade castings can be undermined if certain precautions are not taken to prevent out gassing during the powder coat cycle. The chemistry of the marine grade metal demands the foundry pour at a higher temperature into the sand molds. This higher temperature in contact with the moisture inherent in the sand causes more than a normal amount of steam. This moisture becomes trapped in the aluminum casting. During the heating and curing powder coat cycle, the moisture is pushed out of the casting and causes a bully surface in the powder coat. For this reason, it is recommended that the powder coater operate a de-gassing step. This includes (1) running a pre-bake de-gassing cycle at 50–100 degrees higher than normal, and (2) running the pre-bake cycle at least 100 percent longer than the normal powder coat curing time. On heavier aluminum castings a much longer pre-bake cycle may be necessary. 🌟