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Technical Note 01

Selection Zinc & Yellow Chromate Plating For Our Stand-Off MPV Bracket

We have been asked by several product reviewers why we chose zinc & yellow chromate plating for our Stand-Off MPV Bracket. Our decision was based on the following:

We wanted to offer our Stand-Off MPV Bracket in carbon steel with a protective coating along with stainless steel due to the fact that coated carbon steel is more economical than stainless steel and easier to install fasteners through. Our first inclination was to have the brackets hot-dip galvanize plated per ASTM A153 Class B-2 which is the construction industry standard for hot-dip galvanizing of metal components used in exterior applications. We delivered two dozen samples to a local galvanizing company for trials. They tried several methods but none resulted in the threaded parts of our brackets being able to be threaded together. We then hired a coatings consultant to help us identify coatings that would result in the same longevity as hot-dip galvanized plating. They explained to us that hot-dip galvanizing is a process by which a zinc rich compound is applied to the surfaces of the steel and acts as a sacrificial layer to protect the carbon steel from corroding. The higher the zinc content of the coating and the thicker the coating, the longer it would last as zinc is the sacrificial element providing the protection for this type of coating compound. Hot-dip galvanizing in accordance with ASTM A153 Class B-2 requires a 98% zinc content with 1.5 ounces of zinc coating total for both sides of the steel element being plated. This translates to 2.2 total mils thickness of the plating and 1.1 mils thickness per side. In searching for a plating that would result a 98% zinc content and 1.1 mils thick, they recommended mechanical zinc plating or what is commonly called in the plating industry, "barrel plating". They referred us to American Galvanizing Association's (AGA) paper entitled "Zinc Coatings: A Comparative Analysis of Process and Performance Characteristics ( copy attached ). Page 9 of the document explains the mechanical plating process. The industry standard for mechanical plating is ASTM B633[1]. Table 1 in this standard cites thicknesses required based on service conditions. Our consultant recommended the thickness Class of SC 4 ( very severe ). The Classification Number and Conversion Coating Suffix for this class is Fe/Zn 25 which requires a coating thickness of 25 microns which converts to .98 mils. The finish type they recommended is Type II which is for colored chromate coatings. This requires withstanding a minimum of 96 hours in a salt spray apparatus with no visible corrosion. We asked what this converted to in years and they informed us that there is no industry standard for conversion of hours in a salt spray tank to years of actual exposure. They referred us again to the attached paper from the AGA for durability assessment. Their basis of assessing durability is what they call "Time To First Maintenance" which is based on real world exposures and assessment of the effects of the exposures. They define "Time To First Maintenance" as the number of years it takes for the specimen to exhibit rust on 5% of the steel surface area. They offer Figure 5 on page four for the results of their actual field testing. Based on a 1 mil thick coating of a 98% zinc content coating, the time to first maintenance is 25 years for a suburban exposure. They also state that the results are linear based on thickness of the plating and years of exposure and express this in Figure 5. Based on this figure hot-dip galvanizing

( 1.1 mils of 98% zinc content plating ) will result in 27.5 years ( 25 years x 1.1 mils) to "First Maintenance". Mechanical plating per ASTM B633 Fe/Zn 25 Type II results 24.5 years ( 25 years x .98 mils) to "First Maintenance". We sent a few dozen samples to a local plating company for trials and found that the threaded parts would not thread together completely. This was not near as bad as the inability to thread after the hot-dip galvanizing, though, so we had some hope that this could be worked out. Our consultant explained to our prototype manufacturer and ourselves that the hot-dip galvanizing material in molten form can still contain small bits of metal that are not melted and are contained in the finish coating. The bits of un-melted metal will impede the threading of the components together. Also, when the parts are removed from the dipping tanks, the melted metal can still molten enough to run and form drips which can harden on the surface of the parts and can also impede the threading of the components together. Between our coating consultant and the company that produced our prototypes, they came up with the recommendation that we increase the diameter of the female threaded part of our bracket by the thickness of the coating on each threaded part and it should work as mechanical plating results in a plating that does not have drips or pieces of un-melted metal attached to the parts due to this type of plating process. We had our prototype company increase the diameter of the female threaded part of our bracket by 2 one thousandths of one inch ( 2 mills ). This resulted in the treaded parts be able to be completely threaded together and did not strip the coating off during the threading process.

At this point we felt that we had an acceptable plating equal to hot-dip galvanizing per the construction industry standard ASTM A153 Class B-2, but we wanted to research what our competition was offering for corrosion resistance for the carbon steel components of their products. We found that they offered products with Continuous Sheet Galvanizing per ASTM A653 and ASTM A1046. We looked into both of them and found that the components of their products were cut from sheets of steel that were hot dipped galvanized per these two ASTM Standards. Our concern was the cut edges would not have the protective coating. Our coating consultant told us that the companies that do this type of plating claim that the cutting ( shearing ) of the plated metal resulted in some of the coating being dragged across the cut which would offer protection and that over the years more coating would migrate to the cut edge. This did not sound logical to us so we asked our coating consulting about this. They agreed with us and pointed out that this is not addressed by the American Galvanizing Association. We can only surmise the reason that it is not.

Another issue we found with the plating used by our competitors on their steel components was the thickness of the plating and the zinc content as both play a role in determining " Time To First Maintenance". The competitors that offer components plated per ASTM A653 used Coating Grades of G 40 and G 90. These coatings require a 98% zinc content plating at .36 mils and .81 mils respectively ( See ASTM A653[1] Table 1 or Table 1 on page 6 of attached American Galvanizers Association paper ). Using the "Time To First Maintenance" chart in the attached American Galvanizers Association paper, the Time To First Maintenance for G 40 and G 90 galvanizing is 9 years ( 25 years x .36 mils ) and 20.25 years ( 25 years x .81 mils ). The competitor that offers components plated per ASTM A1046 uses Coating Grade ZM 40. The minimum thickness required in the standard for this coating is .36 mils ( See ASTM A1046[1] Table 1[2] ). The standard also states a variety of metal compositions for the hot-dipping baths and requires the user to declare the composition of the bath used. This competitor states that they use a coating compound with 91% zinc. Based on the "Time To First Maintenance Chart" in the attached document, this coating would result in a "Time To First Maintenance" of 8.36 years ( 25 years x .9286 ( percentage of zinc content versus ASTM A653 plating ) x .36 mils ). Based on this, we selected zinc & yellow chromate plating per ASTM B633 Class Fe/ZN 25 Type II for the protective coating on the steel components of our stand-off MPV Bracket as we felt that this offered the closest grade of protection to hot-dip galvanizing per ASTM A153 Class B-2.

Note 1: ASTM does not allow reproduction or distribution of their printed documents. Please refer to a copy of the document.

Note 2: ASTM A1046 Table 1 requires coating minimum of .40 oz / sf total for both sides of plating compound which is .20 oz / sf per side. This translates to .36 mils or 9.1 microns