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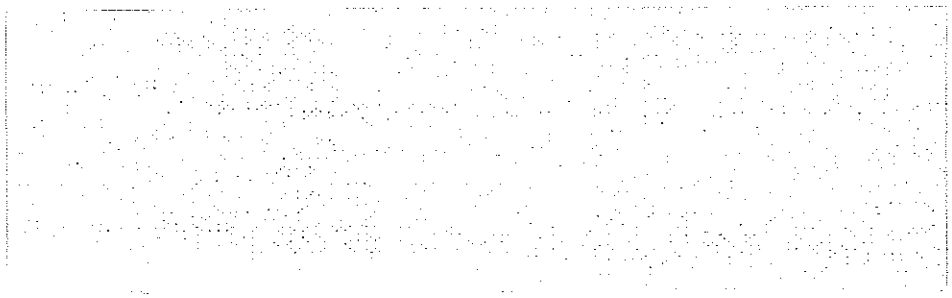
THE DEVELOPMENT OF MICHIGAN'S BRIDGE PAINTING SPECIFICATION

MICHIGAN DEPARTMENT OF TRANSPORTATION

MATERIALS and TECHNOLOGY DIVISION



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THE DEVELOPMENT OF MICHIGAN'S BRIDGE PAINTING SPECIFICATION

G. L. Tinklenberg

Research Laboratory Section
Materials and Technology Division
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Michigan Transportation Commission
William C. Marshall, Chairman;
Rodger D. Young, Vice-Chairman;
Hannes Meyers, Jr., Carl V. Pellonpaa,
Shirley E. Zeller, William J. Beckham, Jr.
James P. Pitz, Director
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The Michigan Department of Transportation has devoted a large research effort over the last eight years to the optimization of a bridge painting program. This report is a summary of that research.

The report will be divided into four sections as follows:

Corrosion Control - An Overview.
Comparison of Formula and Performance Specifications.
The Michigan Evaluation System.
Painting Specifications.

CORROSION CONTROL - AN OVERVIEW

Corrosion control is a five-step process that begins with design. A structure must have surfaces that are accessible in order to be maintained. Certain cautions must be considered since some forms of corrosion, particularly crevice corrosion, proceed at a very rapid rate. Therefore, it is important that we avoid back-to-back angles, discontinuous welds, etc. If crevices cannot be avoided, e.g., behind hanger plates, then special precautions should be taken to slow the crevice corrosion rate. It is also well documented and easily demonstrated that corrosion begins at prominences and at areas of high surface stress. These, in addition to the difficulty in coating sharp edges, are good reasons for minimizing both conditions.

The second step of effective corrosion control is good paint. The major portion of the last section describes how we arrived at a new painting specification. We learned very quickly that good paint is of little value if the other steps are not followed.

The third step is a good specification. A specification must be understandable both to the inspector and the contractor and it must be enforceable. If either of these conditions is not met the specification should be revised. We have had to revise our specification on a yearly basis, which not only takes a large amount of time but also generates a certain amount of confusion in other divisions of the Department and criticism from contractors. Any changes that are made must be supported and evaluated on their own merit, but one cannot forget or disregard the harmful side effects of changing specifications. We are hoping that any more changes will be minor ones.

The fourth step is good inspection. It became fairly obvious to this Department, the FHWA, and many other states that this is a key step. The inspection process must be fair and consistent on a statewide basis. It is also well known that an inspector has a great impact on the overall quality of the job. In order for the inspector to do a good job he must understand the specification and the effects of the judgements that are required of him. Since these were new systems, significantly different

from the old, it was decided that our inspectors should be given some special training in this area. As a result, the Research Laboratory Section conducts a three-day Paint Inspector Course which explains the reasons for the chosen system, the reasons for the various specification requirements, and the effects of the inspector's decisions on the overall quality of the job.

The fifth step is good maintenance. We are just beginning to look at this area. The effects of good maintenance on high performance coating system sections are not well documented. There is one area that can be addressed: no system will be applied perfectly. Although the first four steps, when done properly, will minimize errors, it will not eliminate them. It also seems apparent from field observations and measurements that errors in the application of high performance systems cause localized failures relatively quickly, typically in less than five years.

It is also easily demonstrated that corrosion rates are dependent upon cathode area (the portion of the beam that is not rusting). If there is a small anode (the area where corrosion is taking place) such as an inadequacy in a system and a large cathode (the mass of steel surrounding it) the rate of corrosion at the inadequate area is fairly high. With these facts in mind, it is hypothesized that a repair of these areas five years after the initial painting would significantly extend the life of the entire system.

COMPARISON OF FORMULA AND PERFORMANCE SPECIFICATIONS

There are basically three methods for specifying paints: by formulation; by performance; and, by manufacturer's recommendations. Michigan, for many years, used the formulation method and as a result used a four-coat, red lead/basic lead silico cromate system. In the 1970s many doubts concerning the safety of lead and cromate were raised. (It should be noted, however, that much of the documentation of the harmful effects of lead was for white lead and not red lead.) As a result of this, the encouraging results of non-lead systems from other states, and some limited field experience of our own, the Materials and Technology Division started a research project to evaluate new bridge coating systems. It became readily apparent that due to the rapid development of high performance coatings, the expense of maintaining the required staff and expertise (much less the difficulty in finding this expertise), and the fact that many coatings were available on the market, a new method of specifying coatings was needed.

In order to understand the direction recommended in the area of coating specifications, it is necessary to understand the differences in these two basic methods of specifying coating materials.

Many different ideas come to mind as to what a formula specification is. For our purposes, we shall define it as follows:

> A formula specification is a given set of standards against which a paint is manufactured. These standards govern not only the final product but in many states, including Michigan, each of the raw materials.

It is assumed that the states have optimized the raw materials and the levels of each.

A performance specification is defined as follows:

> A performance specification is a set of performance standards that must be met before the paint is placed on a qualified products list.

The agency in no way regulates the contents of the paint, only that it meets certain performance requirements. It should also be noted that there are two methods of setting up a qualified products list (QPL).

1) A static QPL contains all systems that pass a set level of performance, and

2) A dynamic QPL has a floating level of acceptance. This system then only accepts the top 10 or top 25 percent of the tested systems. (A dynamic QPL is only possible if many manufacturers want the business and not everyone uses the method.)

Historically, many states have been using formula specifications. These specifications have been generated over long periods of time, generally in close cooperation between states and the raw material manufacturers. This system has led to the widespread use of red lead and basic lead silico cromate coating systems in Michigan and many other states.

Performance specifications have only taken hold in a few states since about 1970. It has only been in the last few years that the FHWA has been encouraging performance specifications.

Table 1 lists the advantages and disadvantages of each of the methods.

There were many factors that influenced the decision to use a performance type specification. For many years, one person did most of the work on Michigan's formulation specification. Given the existing conditions, this worked best at the time. With his retirement and the hiring of a replacement, it was possible to do a complete evaluation of existing practices and a convenient time to make any necessary changes. Some promising work had been done by states, including Michigan, in the area of high-performance products and the FHWA was actively promoting the

TABLE 1

ADVANTAGES

Formula

1. If results are needed quickly, the process usually can be accelerated with additional personnel.
2. Easy to enforce field requirements since formulator is only expert on a specific product.
3. Can cater to special problems.
4. Long proven track record.

Performance

1. Good tolerance to personnel changes, once system is established.
2. Technical service is usually provided by the manufacturer, thus reducing workload.
3. Relatively short changeover time.
4. Easy to change formulations.
5. Easy testing requirements.

DISADVANTAGES

Formula

1. Process greatly delayed by loss of key personnel.
2. Agency must provide technical service on their formulation, thus reducing the amount of time available for improving the formulation.
3. Slow changeover time.
4. Cost of the formulation can vary independently of the rest of the coating market.
5. Hard to change "my" formulations.

Performance

1. Progress depends on size and amount of available equipment.
2. Can lead to hard feelings when approved products are eliminated.
3. Difficult to address small or specialty markets.
4. No long track records of good performance.

use of performance specifications. In reviewing the advantages and disadvantages of each system, it was decided to actively pursue the adoption of a performance type specification for the following reasons: the excellent performance of high-performance coatings as compared with our existing formulation paint, the existing equipment and manpower, the apparent economic advantages, and the possibility of alleviating public inconvenience by the time saved due to the use of two-coat systems rather than four-coat, and the fast drying properties reducing the likelihood of getting paint on cars. In arriving at this conclusion, however, one of the questions which arose was; if this system is so good why do so many other states still use the formulation method? After many discussions with various state agency representatives, FHWA representatives, and a look at the history of how we arrived at our formulation specification, we concluded that:

1) Many states simply do not have the personnel or facilities to do their own research with either type of specification. Therefore, many do the next best thing which is to depend on other states and/or manufacturers recommendations.

2) In the overall highway picture painting is not considered to be of great importance for two reasons: first, everyone is more familiar with painting that is done for decorative purposes; and second, the corrosion process is so slow it is easy to defer painting until a later date.

3) Many raw material suppliers have made formulas available to agencies which are easily specified. It also is easier to write a contract since no proprietary names are used.

4) Formulation paint systems have a long history of field use. (It should be noted here that this implies a long history of use but not necessarily a long history of optimum performance.)

These observations are not to be taken as criticism of anyone's practices but they are important in order to understand how Michigan arrived at the decision to use performance specifications.

Once the decision to go to performance specifications was made, we had to choose which type of system to use. There are many schemes to choose from but basically two methods are being used. The first is to have the paint supplier hire a contractor to apply his paint to an actual bridge and then evaluate the application and corrosion protection over a given time period. The Florida Department of Transportation has had a great deal of success with this method. A modification of this method is to have state crews apply the paint, thus reducing the cost to the supplier. The second method is to perform accelerated laboratory evaluations. In this test the coatings are applied to panels, typically 6 by 3 in., and exposed to various laboratory tests to determine corrosion performance.

There are many requirements for each system. The bridge painting method requires a large investment on the part of the supplier, a highly

corrosive environment to give results in the relatively short time of three to five years, easy access to facilitate inspection, and many structures in a similar environment. The laboratory testing method obviously requires a fairly expensive evaluation laboratory and enough money to maintain an evaluation program.

The Florida Department of Transportation has used the bridge painting method for many years as they have many bridges that meet the various requirements on their coastal waterway system. The biggest advantage of the system is that it provides 'real-world' results for both the application and corrosion control characteristics. The major disadvantages are that it requires a sizable investment both in time and money on the part of the supplier, and it takes three to five years to get results.

The Michigan Department of Transportation has chosen the laboratory evaluation method. We do have many bridges in a highly corrosive environment in the Detroit area but the cost of traffic control both for the application and inspection would make this a very expensive operation. This large cost would give the major manufactuers an unfair advantage since the small firm would be hard-pressed to invest the required amount of money over the five-year period in the hope that its product will be placed on a QPL. In addition, the public inconvenience factor would be great due to the many required lane closures. Michigan already had an evaluation laboratory and the necessary application equipment to duplicate field equipment; therefore, the laboratory method was chosen.

There are some advantages and disadvantages to the laboratory method:

Advantages

1) The testing period is shorter, typically less than two years.

2) The cost to the supplier is small requiring only the supplying and shipping of two to four gallons of each product to be tested.

3) More product variables can be checked; e.g., a product's tolerance with respect to various degrees of surface preparation.

4) The product is tested, not the contractor. Since one person does all the application with the same equipment, the variability of many applicators and different pieces of equipment is nonexistent.

Disadvantages

1) Accelerated test results do not always correlate with real-world results. (It should be noted, however, that according to a study by the Steel Structures Painting Council, if a system performs well in the tests, chances are very good that it will perform well in the field.)

2) Very susceptible to the contractor's cliche that, "Things are different in the lab. Those guys don't know what it's really like in the field."

A state's choice will depend on the value it places on these items: the availability of a good test environment, and the availability of laboratory facilities. For Florida and Michigan, the choices were relatively easy, but it must be understood that an accelerated testing program does not guarantee good products. All we hope to do is reduce the chances of using a poor system. By using various pieces of equipment, it is felt that good performance in a battery of tests greatly reduces the risk of poor performance in the field.

The establishment of a laboratory performance specification has been, and continues to be, a learning experience. There have been many changes in the testing procedures, the application, and the documentation over the last three years. The rate of change is slowing down, however, and many of the recent changes in the system are additions to, rather than modifications of or subtractions from, the system.

In order to keep the number of samples down to the limits of our testing equipment, we had set up some guidelines. Initially these were:

A) No one system will be optimal for all conditions. Therefore, we set up four groups:

1) Coatings for steel that was to be blast cleaned to a near-white either in the shop or in the field.

2) Coatings for steel to be spot blasted, those areas primed and the entire structure top coated.

3) Coatings for A588 and other heavily rusted steel.

4) An experimental group which could contain various condition studies or special problems unique to Michigan.

B) A supplier could submit only one system in each group, except Group 4.

1) All systems must be lead and chromate free.

2) The products submitted must come from the supplier's standard product line and be accompanied by its history of good field performance and/or accelerated test results.

These guidelines did reduce the number of submissions; however, not by nearly enough. As a result, additional requirements for each group were specified as follows:

Group 1

A) After a six-month literature search and numerous conversations with other governmental agencies and suppliers, it was decided to initially

limit submissions only to inorganic zinc-rich systems. The idea being that as long as we were going to radically change the system we would specify what is generally considered the best, especially since the cost for most of the systems was so close.

B) The system must be a two-coat system. A change in our standards needed a good selling point; and this was it. The reduction in traffic closures from that required with our old four-coat system, in conjunction with increased life expectancy, made the system sell itself.

Group 2

A) The system must be brushable. Many of the structures that were being coated with these systems were small and were done with county personnel who did not have spray equipment.

B) The system can consist of any number of coats but must be at least two. Very early in the testing, and based on some small test areas done in previous years, the chances of error in a one-coat brushed system were so high all results were poor.

C) The vehicle may be any type; however, the system must be compatible with old red lead alkyd systems.

Group 3

This is the newest addition to the testing program. Previously all the testing on weathered weathering steel was done in the experimental group (now Group 4). Currently we have taken the best of the generic class of products over this substrate and developed a group around it. Consequently, in this group we only test a three-coat system consisting of an epoxy type zinc-rich primer, an epoxy or urethane intermediate coat, and a urethane topcoat.

Group 4

Due to the special nature of this group, no requirements were needed. In essence, we decide what to test and how. Samples are requested of and/or submitted by the supplier at his option. However, we usually have a specific problem area on which we concentrate. In the past it has been coatings for weathering steel. In 1985 it was a comparison between one- and two-component inorganic zinc-rich primers and in 1986 it will be low VOC paints.

Over the last four years these requirements have changed.

A brief history of the changes that occurred and the reasons for these changes follows.

Appendix A is the 1986 request letter for samples containing the current requirements.

Group 1

A) One of the first added requirements was that the primer of the system must meet the SSPC definitions for a zinc-rich coating (organic and inorganic). In order to assure us of the uniformity of the submitted systems and to reduce the number of submittals, some minimum requirements were needed, thus the use of the already existing SSPC definitions. There also were some excellent results with some organic zinc-rich systems, including some submitted to Group 3 of our testing program that indicated it was unfair to exclude all organic zinc-rich products.

B) In 1982 the requirement was added that the zinc-rich primer must be a single-component type. Again, we needed tighter restrictions to reduce the number of submittals to a workable number. This one was chosen for the following reasons:

1) In our initial testing the performance of the two-component zinc-rich primers was not significantly higher (if any higher) than the one-component zinc-rich primers.

2) In our initial painting contracts we used two one-component and one two-component zinc-rich primers. The field problems with mixing and application were much greater with the two-component than the one-component primer. While it is true that this may have been characteristic of this product, another product perhaps not having all the same problems, this fact did contribute to our using the one-component limitation.

3) In the laboratory, the one-component zinc-rich primers seemed to tolerate more application errors than the two-component zinc-rich primers, especially in the inorganic area which was a limitation in our initial testing program. The errors that occurred in mixing multicomponent primers and the elimination of mixing a powder component in the field were also considerations.

4) The bridge painting industry was accustomed to working with one-component products and seemed to have less resistance to changing to the 'new system' if it more closely resembled the 'old system.' In 1985 a program was started to evaluate the differences between two-component and one-component inorganic zinc-rich primer. The two-component products reportedly had some advantages that made them better suited for shop application, particularly cure times and higher cohesive strength. Additionally, during this same time frame we were having field problems with the single-component inorganic zinc-rich, vinyl systems. Some of these field problems could be attributed to the exclusive use of single-component, but not all. It appeared that for badly corroded steel the organic zinc-rich systems offered some advantages. In the shop, however, there was concern over the use of organic zinc-rich systems on faying surfaces. For these

reasons in 1986 we decided to use only organic zinc-rich in the field and inorganic in the shop. Group 1 in 1986 will be inorganics, one- or two-component and Group 3 will be for organic zinc-rich systems.

C) The topcoat must be a vinyl, epoxy, or urethane. (Any or all may be submitted for use over the same primer.) We did not have very good initial results with any acrylic or chlorinated rubber-type topcoats, but much better success with the other three types. We needed some additional limitations but we also wanted to determine the differences in the performance of these topcoats. Since we were thinking of going to a total shop system, we felt epoxies or urethanes would be better than vinyls due to their higher abrasion resistance. In the field, however, we wanted the greater application temperature range the vinyls offered.

In 1984 and 1985 we started having some field problems with high build vinyl topcoat systems. The three major ones were:

1) Differential Chalking - The vinyl chalked in what appeared to be spray patterns. If the structure had chalked uniformly chances are there would have been no complaints. Alkyd systems had been chalking uniformly for years. The contrast between the chalked and unchalked areas was unsightly.

2) Delamination of the Topcoat - The vinyls seemed to have a marked effect on the cohesive strength of the single component zinc-rich primers.

3) Lack of Inspectability - In many cases something could look good and be wrong. It takes a higher than usually available skill level to know this. What was needed was a system that if it looked good, it probably was good. The epoxy intermediate with a urethane topcoat system was this type of system.

For these reasons the 1986 program will concentrate on the epoxy intermediate and urethane topcoat systems. Vinyl intermediates and vinyl topcoat systems will be studied but only on an experimental basis.

There are many legitimate criticisms of these requirements. One must keep in mind, however, that the entire system must work within the limits of the available equipment. For this reason, limitations are necessary. It is hoped that these will be broadened but it is obvious that all limitations cannot be removed due to the vast number of products that are available.

Test Methods

The search for good accelerated test methods is a slow process since every test has some drawbacks. Over the past three years we have used seven different tests. Five of these are still used and we are in the process of evaluating a new test chamber that has been used by KTA-Tator, Inc. for a number of years. Two of the tests simply didn't generate differences fast enough to merit their use. In order to get some idea of our program,

all of the equipment or procedures are listed below with some of the reasons for their use or suspension.

Salt Fog (ASTM B117) - The salt fog testing is probably the harshest environment we can use. There are many criticisms of the method; however, it is the most widely used method in the industry. The test does not always correlate well with field data. However, as pointed out in a recent SSPC report, the chances of a product performing well in the field are significantly increased if the same system performed well in the salt fog test.

Ultraviolet Condensation Chamber (ASTM G53) - This test we used as a replacement for the weatherometer. It is much cheaper to operate. The test consists of eight hours exposure to ultraviolet light at 60 C followed by a four-hour cycle at 40 C at which time moisture condenses on the panels. Basically this test gives some idea of the aesthetic performance, not necessarily of corrosion performance, since there is no electrolyte in the test chamber or on the panels.

Aerated Brine - This test was run on 1979 and 1980 samples. The results were much better than expected and after 6,000 hours there was not enough separation of systems. In fact, almost all systems performed very well. As a result of this, it was decided to drop the test since it required too much time for the usefulness of the results.

Aerated Distilled Water - This test was also run on the 1979 and 1980 systems. It is no longer run for the same reasons the aerated brine was discontinued.

100 Percent Humidity Room - Starting in 1981 we tested the systems in a 100 percent humidity room at 77 F. After 6,000 hours, the results were not all that useful. If a coating blistered in this environment it seemed to do so in the first 500 to 1,000 hours. Those that did blister slowly got worse, but very slowly. As a result, we plan on modifying the test by exposing the panels in some way to environmental pollutants, after 500 or 1,000 hours initial exposure in the moist room. (This will probably be done by bubbling SO_2, CO_2, and NO_x in water and then spraying the panels with this solution on a weekly basis, although the exact procedure has not been set up at this time.)

Weather Cycles - There seems to be a need for cyclic testing procedures that look at the synergistic effects of various environments. There is no standard combination of tests that is in use in ASTM, NBS, SSPC, or any other national testing organization. As a result of this, we decided to begin work on a weather cycle of our own. We felt that a number of elements were necessary: ultraviolet light; heat; cold; ice abrasion; moisture; and NaCl.

In order to make the system work in the typical work week and to place varied importance on the elements, the following procedure was set up:

1) Panels are placed upright in a pan with 2-1/2 to 3 in. of water and put in a freezer at -20 F at 4 p.m.; the pans are removed from the freezer and put in a 120 F oven at 8 a.m. the next morning. After eight hours, the panels are then frozen again overnight. This is repeated five times.

2) Panels are placed in an ultraviolet condensation chamber for 200 hours.

3) Panels are placed in a salt fog cabinet for 50 hours.

4) Back to Step 1.

This procedure has worked well for three years and has generated some interesting failures. As with all other tests, there is no correlation with real-world life spans. This type of correlation, if it exists, will take at least 20 years to document.

Outside Exposure - For the sake of curiosity, we also placed a panel on a rack in an outdoor storage area. It is expected that there will be no problems after two years. In almost all cases this is true.

Cyclic Environment Chamber - This test began on the 1982 panels and on retained panels from the previous years. It consists of a wheel that holds six panels on its circumference (any number of these can be ganged together, our machine will hold 96 panels). This wheel makes one revolution every four hours in 60 degree increments. The lower portion of the wheel (bottom 120 degrees) is immersed in a 3 percent salt solution. This then immerses the panels for 80 minutes. The top portion of the chamber has ultraviolet lights and heaters that maintain the air temperature at 120 F. A machine very similar to this has been used by KTA-Tator for a number of years, with some very impressive results. We owe thanks to KTA-Tator, Inc., for letting us use the design and helping us in the construction of this equipment. The theory behind this piece of equipment is that forcing water into and out of a coating will greatly increase its rate of failure. This equipment is new and yet to be proven. We hope that it can provide us with a shorter test than is currently available both for research and quality control.

Panel Preparation

The panels are varied as to the groups and conditions for which we are testing. As a result of this, the total panel preparation procedure is complicated to describe. There are a number of characteristics that are common to all groups, these include:

1) All panels are 3 by 6 in. This allows us to double the capacity of the ultraviolet chamber which was considered more important than using the recommended 3 by 12-in. size.

2) All panels are a minimum of 1/4 in. thick, which is the thinnest section that is found on a bridge.

3) All panels are of bridge grade steels usually A36 or A588.

4) All panels were photographed before blasting, after blasting, after each coat of paint, and periodically throughout the test.

5) All panels are allowed to age at least four weeks before accelerated testing.

We are looking for various effects in the different groups. This requires that for each group we have different panel conditions. A list of these conditions and the reasons for their use in the 1981-82 tests is as follows:

Group 1 - (near-white blasted)

1) All panels were blasted with silica sand to a near-white state with a 1.5 to 2 mil profile.

2) For each system six A36, five for accelerated testing and one to retain, and one environmentally exposed (heavy NaCl area) A588 panel were prepared. The A36 panels were then used as controls and were run on all systems in each group. The A588 panel was prepared in order to establish a data base for work in Group 3 and other research projects.

3) All panels were airless sprayed with typical field equipment fitted with manufacturers' recommended tip sizes to obtain our specified minimum dry film thickness of 2.5 mils.

In the first three years that the panels were prepared, the system evolved into our current procedure. This procedure was difficult to establish because so many variables had to be considered. For example:

1) Conventional versus airless spray equipment. Conventional equipment is much cheaper, easier to clean, easier for product changeover, and more versatile at the gun. The major problem is that none of our contractors were using conventional spray techniques and some manufacturers did not recommend conventional equipment for their products. Therefore, in 1980, to more closely duplicate actual practice, we sprayed all panels with the most commonly encountered airless pump.

2) In 1980, we sprayed the panels to the predicted required wet film thickness as determined by the product's listed volume solids, and found that in general the primers were too thin. It is theorized that the surface profile in conjunction with our method of calibration of our dry film thickness gages (shim method) accounts for these discrepancies. However, in our tests to determine the required minimum dry film thickness these two conditions were present. Therefore, in 1981 we sprayed the products so as to obtain a minimum of 2.5 mils (in order to do this we generally figured

what would be required for a 3 mil dry film and added 1 to 2 mils to make up for what seems to 'disappear' into surface profile). For example, with a volume solids of 58 percent we required 7 to 8 mils wet to obtain the required 2.5 minimum and for a product with 48 percent volume solid 8 mils wet was required.

3) All topcoats were first mist-coated, allowed to dry a short period of time (typically 5 to 10 minutes) and then topcoated to the calculated wet film thickness. All the backs of the panels were sprayed in one full wet coat. By using this procedure we could get some feel for a product's tendency to 'gas' (form blisters due to solvent fumes or air entrapment). All products were sprayed as received unless the product literature specifically stated that the paint must be thinned. With this in mind, our definition of a mist-coat was that amount of paint which would just give a discontinuous film after leveling, or in other words, a coat that is full of pinholes. The thickness of the mist-coat is somewhat dependent on the type, viscosity, and leveling ability of the paint. (It should be noted that in the 1982 tests, all systems supplied gassed on the back of the panels while there was little, if any, on the front.)

Group 2 - (no lead or chromate, brushed, compatible with old alkyd)

1) All panels were A36 but the surface conditions prior to and after blasting are listed in Table 2.

TABLE 2

No. of Panels	Before Blasting	After Blasting
6	Mill scale	Near-white
1	Retained red lead system from prior years	Gradient blast
1	Four-coat red lead system that had been scribed three times the entire length of the panel, then exposed in the salt fog cabinet for 1,000 hours	Gradient blast

2) All panels were brushed with each coat applied perpendicular to the proceeding coat.

Group 3 - (in 1985, Group 4)

This group contains all sorts of experimental conditions which require many different surface preparation techniques. In the results section of this group the surface condition and preparation must be carefully noted. The procedures have changed only a little over the years. In general we test all products over A36 carbon steel blasted to a near-white. If a product is for some special use we test that type of substrate also. One change

of note is that we no longer blast with silica sand (silica sands cannot be used in Michigan as the dust levels are too high). We use either a mineral sand, nickel slag or copper slag.

After the panels have aged, the hole that is used to hang the panel during the drying of the paint is filled with 100 percent solids epoxy resin. The panel for the salt fog, the moist room, the ultraviolet condensation, the outside exposure tests, and the Envirotest are scribed. In previous years, the hole was near the top half of the panel and the scribe on the bottom. This led to some rust staining of the entire panel due to an incompletely filled hole; therefore, the scribe is now on the other half of the panel and the panel tested with the plugged hole down. The scribe is a X with 2-1/2-in. legs except for the gradient blasted panels which are scribed with one line across the various zones. A utility knife is used to scribe the panels and each panel is checked with a microscope to be sure the scribe has penetrated all coats of paint.

Laboratory Evaluations

A coating is evaluated in two major categories: its application and its performance. A coating that is hard to apply but has good performance is just as bad as a coating that is easy to apply but has poor performance. Paints were being evaluated by the manufacturer in various tests but the importance placed on each of these tests was as varied as the formulator. What was needed was a rating system that could be used to evaluate both of these areas and their interrelationships. After many lengthy discussions with manufacturers, researchers, other states, etc., it was concluded that no such system existed. As a result, in 1981 we started work on a system of our own.

A rating system must take into account all aspects of a coating's characteristics, relate them to one another, and establish some minimum acceptable standards. Figure 1 lists the various characteristics that are evaluated and the relative importance of each. Michigan is in the process of establishing minimums for each area. An agency may place more or less importance on an item simply by raising or lowering the minimums or changing the rating factors. (The definitions for each rating are listed in Appendix B.)

There were many considerations in setting up the weighing factors. In general, we felt that a product's application characteristics will be reflected in its performance; therefore, performance was given a greater value than application. This same idea holds for the other application qualities as well. Ultimately, the product's sprayability is affected by the others. This is not true, however, for the product's performance. How a product rates in one test has no effect and possibly no relationship with its performance in another test. Performance weightings were assigned to the tests by their use in industry, the percent of bridge steel that is exposed to this type of environment, and the predicted failure rate. For

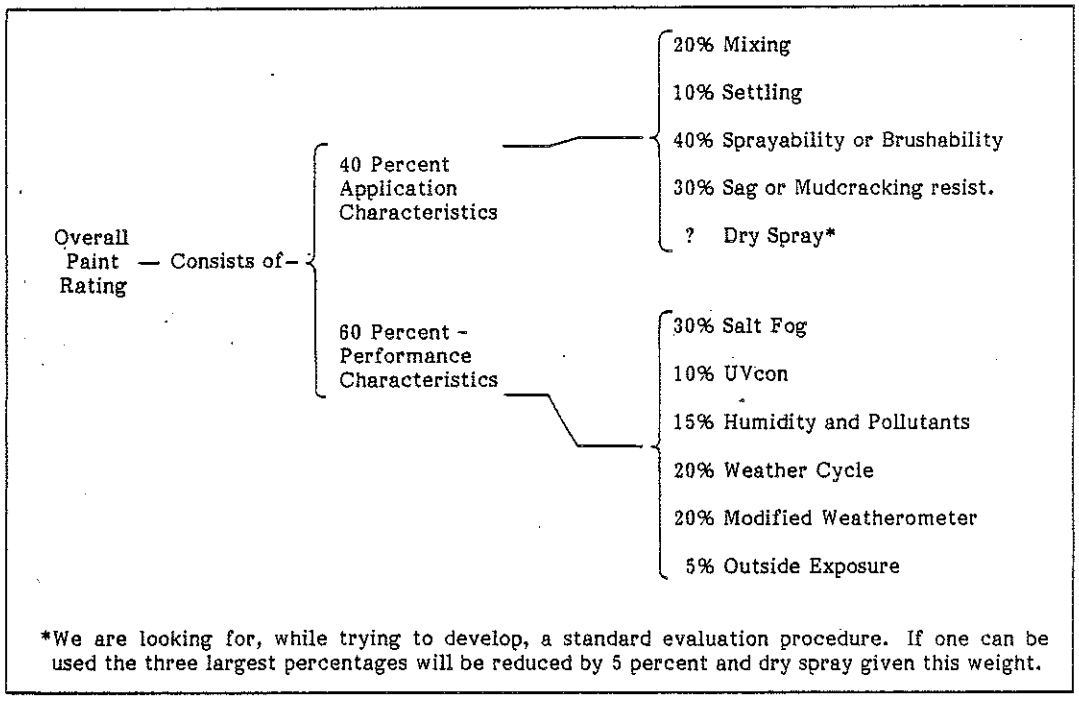

Figure 1. Proposed weighted rating system for the 1983 samples.

example, the salt fog is widely used, almost all the steel is exposed to some level of chloride, and its failure rate is quite high. As a result this is weighted high. On the other hand, the outside exposure is unique to our area, very little bridge steel is in such a mild environment, and the failure rate is slow, resulting in a low weighting. (We are looking into a site on a bridge over an Interstate freeway. If we use this exposure site, the weighting may increase.) Three of our tests are modifications of, or combinations of various tests with no proven history of significance, thus they are at this time, rated about equal.

Record Keeping

In order to keep track of each system, each panel, and the system's performance, a record keeping system had to be set up. The system has undergone many changes over the years it has been in use. Most of these changes were arrived at through a trial and error process making a complete history of the process lengthy and unnecessary. Therefore, only a summary of our current system follows.

Record keeping consists of four items:

1) Product information sheets (Fig. 2).
2) Panel test record sheets (Fig. 3).
3) Progress log
4) Photo log, and
5) All records are transferred to a computer data base for analysis.

PRODUCT INFORMATION SHEET

PRODUCT: _____ PANEL NUMBER: _____

SUPPLIER: _____ REPRESENTATIVE: _____

GENERIC TYPE: _____

DATE REQUESTED: _____ DATE RECEIVED: _____ QUANTITY: _____

USE: _____

PRIMER OR TOPCOAT: _____

APPLICATION DATA:

Recommended DFT _____ mils Vol. Solids _____ % Recommended WFT _____ mils

Thinner _____ Generic Type _____ Thinning Limits _____ %

APPLICATION: Method: _____ Tip Size: _____ Tip Pressure: _____

COST DATA:

$/gallon: _____ mil sq ft/gal (theoretical) _____ $/sq ft at Rec. DFT _____

APPLICATION SUMMARY:

Mixing: _____

Settling: _____

Spray or Brush: _____

Sag or Mudcracking: _____

Dry Spray: _____

REMARKS: AVG DFT PRIMER _____

AVG DFT TOPCOAT(S) _____

ACCELERATED WEATHERING SUMMARY:

Test	Panel #	DFT	
Salt Fog:			1000hr ___ 2000hr ___ 3000hr ___ 4000hr ___ 5000 hr ___
UVCON:			1000hr ___ 2000hr ___ 3000hr ___ 4000hr ___ 5000hr ___
Humidity:			1500hr ___ 3000hr ___ 4500hr ___ 6000hr ___ 7500hr ___
W.C.:			2 cycles ___ 4 cycles ___ 6 cycles ___ 8 cycles ___ 10 cycles ___
Outside:			1 year ___ 2 years ___ 4 years ___ 7 years ___ 10 years ___

WEATHERING REMARKS:

_____

_____

_____

_____

_____

_____

REMARKS: _____

_____

_____

Figure 2. Product information sheet.

1014 (11/83)

PANEL NO. _____

PAINT PANEL TEST RECORD

Manufacturer _____ Project No. _____ Date _____

Product(s)	Sample No.	Date Applied	Time
1st Coat			
2nd Coat			
3rd Coat			
4th Coat			

Surface Condition before Preparation _____

Surface Preparation _____ Date Prepared _____

Application Method: Brush _____ Roller _____

Conventional _____ Gun _____ Fluid Tip _____ Air Cap _____

Airless _____ Pump _____ Gun _____ Pressure _____ Orifice _____

Film Thickness: Instrument Used: _____

	Coat	1	2	3	4	5	6	7	Average	Date	Time
Front	1st										
	2nd										
	3rd										
	4th										
								Total			
Back	1st										
	2nd										
	3rd										
	4th										
								Total			

Physical Test:

Abrasion-ASTM D-968: _____ Liters of Sand _____ Abrasion Coefficient

Adhesion-Crosscut: _____ % Retained

Remarks: _____

_____

Figure 3. Panel test record sheet.

When samples arrive they are entered into a log on the supplier's file envelope, and product information sheets are made. A product information sheet contains all the pertinent application data as listed on the manufacturer's data sheets, the intended use of the product, the generic type, amount received, date received, cost data, an application summary, and a performance summary. Originally, at the end of the tests these sheets were to be filed in a series of three-ring binders. These binders would group the products by generic type, company, year, and panel number. With this system, given any piece of data, we could very quickly find a company, type, or yearly history.

Problems arose because of the amount of data that was obtained. The original system was set up based on the 1979 total of three companies submitting products in three groups. In 1984, 20 companies submitted a total of 58 different paint systems. With approximately 300 data points per system evaluation, the record keeping really became a problem. Therefore, starting with the 1983 data, we are computerizing the entire system. Although the data entry process is time-consuming, this data base will allow us to look at some variables that previously got lost in the system.

After it is determined what group a product is in and how many panels are needed, the panels are numbered and panel test record sheets are made out. These sheets are a history of the panel from prior to blasting to the end of its performance test. All application, surface preparation, film thickness, and performance data are recorded on these sheets.

We must do many different products at the same time. To keep track of a system's progress, a checklist by group is made. All the systems of a group are listed and when a step in the coating process is complete, the appropriate box is checked. Since the coating process involves a minimum of 10 steps, the keeping of the log is essential to avoid omitting a step since various technicians do the work.

The photo log is a time-consuming but valuable tool. It assures us that all the steps have been completed and gives us a visual record over the life of the panel. A panel is photographed before blasting, after blasting, after each coat of paint, after scribing, and at various intervals in the testing program. These photographs are then filed by panel number.

The computer program is capable of analyzing the data in a variety of ways. Some of the current possibilities are:

1) A ranking within a group,
2) A ranking of a generic type of system,
3) A year-to-year comparison of groups,
4) A year-to-year comparison of the same product,
5) An overall group level of performance,
6) Performance versus dry film thickness, and
7) A comparison of dry film, wet film, and weight film thickness.

There are other variables we are investigating but to date the programs have not been developed.

After the testing and data evaluation are complete, in many ways the work has just begun. Someone must determine what level of performance is acceptable, publish the qualified products list, explain to those who are not on the list why they are not (probably the most difficult part of the whole scheme), make sure there are no inconsistencies between the QPL and the specification, etc. Although this may appear to be a lot of work on something as insignificant as paint, the cost savings in one year on only one aspect of this project which resulted in total shop painting was enough to pay for this testing for years to come.

PAINT SPECIFICATIONS

The evolution of Michigan's current bridge painting specification was slow and at times a costly process. In order to appreciate the complexities of specification development (e.g., the many factors that affect the wording in specifications and the type of specifications that were necessary) a yearly history will be presented.

When addressing specification development, especially at a state level, there is some background information that must be kept in mind throughout the process. This is:

1) Painting specifications are used and interpreted by people who are not corrosion control experts.

2) Many times things are criticized simply because they are more complicated or initially more expensive than past practices. This often occurs with no long-term cost analysis.

3) People resist change. The idea in the old saying "if it works don't change it" is well established.

4) There is little or no tolerance for failure in field experimental systems.

Many times throughout the development of specifications changes were necessary for one of these reasons.

In 1978 the Department's standard repaint system was a four-coat red lead alkyd system. It, or variations of it, had been used for many years. During the late sixties and early seventies some limited field work had been done with inorganic zinc-rich vinyl systems. Up to this point they appeared to be doing quite well; therefore, another research project was undertaken comparing multi-component and single-component inorganic zinc-rich systems. In observing this experimental work it became apparent

that the specifications were weak in a number of areas (one of the original experimental specifications is in Appendix C).

1) Although the abrasive size was specified no equipment or procedure was available to test the abrasive. Therefore, for years this provision was ignored.

2) Many times we were told that a near-white blast was specified in order to ensure a commercial blast. This was normal for many years. As a result the near-white requirements were not enforced and the normal blast was a 'commercial' even though a near-white was specified. (When the near-white requirements were enforced to ensure adequate performance of the inorganic zinc-rich systems, the bridge painting contractors were caught off-guard.)

3) A number of requirements were not enforced including:

1. Removal of fins, tears, slivers
2. Vacuuming
3. Blasting joint areas as a unit
4. Providing scaffolding for inspection
5. Mixing
6. Thinning

Much of this was not done because either the inspector thought there was no need for the requirement or the contractor convinced him there was no need.

By 1980 enough work had been completed in the laboratory to start a limited QPL for the field painting. Also at this time, there was the need for a new shop painting specification. For approximately 15 years, Michigan had used weathering steel for new construction almost exclusively. When the need for a shop specification arose the old method (shop prime, field topcoat) with the new systems was used. A method of inspecting profile height was added to both specifications and pictorial blasting standards were given to inspectors. Field blasting showed remarkable improvement.

In 1981 the first shop primed bridge steel started to arrive on the job site. The problems of who was responsible to clean and repair the surfaces prior to topcoating also started in 1981. These problems eventually grew to such magnitude that it was decided to either totally paint in the shop or totally paint in the field. (A summary of some of the problems is in Appendix D.)

The field problems of the early eighties centered on adequate dry film thickness. One of the major problems with inorganic zinc-rich primer is that it has a threshold dry film thickness to give adequate performance and that this thickness is higher than the amount of paint required to give a uniform appearance. This meant that application technique and dry film thickness measurements were very important. The inspectors were not

accustomed to making these measurements. In the past they were told if it looked good it probably was good (to date this still remains one of the biggest advantages of a four-coat alkyd system on bridges). Additionally conflicts concerning the method of calibrating dry film thickness gages started to occur. The 1982 version of the specification specified how to calibrate the dry film thickness gage.

The problems with cleaning shop primed structures, cleaning of riveted existing structures, and the need to start painting weathering steel structures led to the development of four special use specifications.

Type 1

Type 1 was for painting existing structures with an inorganic zinc-rich and a high build vinyl or epoxy.

Type 2

Type 2 was used for the painting of existing riveted or truss structures that were difficult to clean. It specified a commercial blast with a four-coat moisture cure urethane system.

Type 3

Type 3 was for the total shop painting of new steel. It used an inorganic zinc-rich with an epoxy topcoat.

Type 4

Type 4 was for the painting of weathered weathering steel with an epoxy zinc-rich primer, an epoxy intermediate, and a urethane topcoat.

These specifications were used until 1986 when circumstances mandated some other changes. The following is a brief summary of the current status of each of these specifications.

Type 1

In 1984 a large number of failures directly caused by insufficient primer thickness started to show up on the field painted structures. At this time delamination problems and inconsistent chalking problems started to develop with the shop primed field topcoat system. Early failures were evident on previously badly rusted portions of structures. All this cast a cloud over the zinc-rich vinyl system. This, in addition to the successful performance of the Type 4 Specification, led to the elimination of Type 1 in 1986.

Type 2

The Type 2 specification was developed due to pressure from an association of road building contractors. They felt that it was impossible to properly clean certain types of structures and something was needed that could be applied over a commercial grade blast. Moisture cure aluminum

filled urethane systems were the best of the available systems in the laboratory testing program, and others had reported success with it. Therefore, it was chosen. For a variety of reasons most of the contractors who requested this system did not specialize in bridge painting. The bridge painting contractors routinely started requesting that they be allowed to substitute the Type 4 specification in place of the Type 2 at no extra cost to the state. Since it was generally concluded that the Type 4 paint types were better, some problems with systems similar to Type 2 systems were found in the laboratory and field and for all of 1985 no Type 2 systems were applied, the specification was dropped in 1986.

Type 3

The total shop system is now well in place. The initial resistance, shipping and handling problems, erection problems, and damaged coating amounts and repair procedure problems have all been dramatically reduced over 1985. To date we have built about 40 structures using this specification. Currently most structures require less than 0.5 percent of the total surface area be repaired. The worst case was approximately 3 percent of the total surface area, while a number of structures require no repairs that are severe or large enough to require sandblasting. The cost savings is estimated between 10 and 30 percent and due to painting under nearly ideal conditions, the overall quality is greatly improved.

In 1986 the only change is to require the urethane topcoat on all surfaces instead of just the facia beams as in the past. Previously the epoxy intermediate and the urethane topcoat were the same color. This led to problems of inspectability on the facias. It was almost impossible to determine if the facia had been properly coated. The epoxy seemed to retain dirt much better than the urethane so after erection the appearance soon was much different from the facia. This dirt retention problem also highlighted any repair area since all repairs (including those on interior beams) utilized the urethane as insurance of performance in the damaged area. These three reasons led to changing the color of the intermediate epoxy to white and requiring the urethane over all the beams.

Type 4

Specifications similar to the Type 4 system have been used by a number of states for many years. One of the major advantages of this system is that at least for the intermediate coat and the topcoat if it looks good it probably is good. The only problem to date is the overspray problem of the epoxy and urethane. Currently it is obvious that the painters will have to take more precautions than used in the past.

In 1986 we will have two specifications - one for shop painting and one for field painting. The 1986 versions of these two specifications are contained in Appendix E. These specifications are the result of years of research, many hours of meetings, and numerous re-writes; however, they are not perfect. Any suggested improvements would be most appreciated.

APPENDIX A

STATE OF MICHIGAN

TRANSPORTATION COMMISSION
WILLIAM C. MARSHALL
RODGER O. YOUNG
HANNES MEYERS, JR.
CARL V. PELLONPAA
SHIRLEY E. ZELLER
WILLIAM J. BECKHAM, JR.

JAMES J. BLANCHARD, GOVERNOR

DEPARTMENT OF TRANSPORTATION

MATERIALS AND TECHNOLOGY DIVISION
SECONDARY GOVERNMENTAL COMPLEX
POST OFFICE BOX 30049, LANSING, MICHIGAN 48909
PHONE: (517) 322-1085

JAMES P. PITZ, DIRECTOR

January, 1986

Dear Mr.

Once again it is time to request bridge paint samples for testing in 1986. As you can tell from the size of this packet we now have computer printouts from the 1983 and 1984 programs. In all packets are the procedures for sample submission, test procedures, evaluation procedures, evaluation definitions, and computer printout explanations. If your company supplied products in either of these two years, your results are also attached.

We are now working on two formal reports, one of which will describe the development of the bridge paint evaluation program and the other is an evaluation report on the field painting of weathered weathering steels. It is hoped that these will be written in the next two months and published within the next six months. After these are written we would like to start the paint application of 1986 products. Therefore, we will be accepting products between March 1 and April 30, 1986. Although we can't operate on a rigid first-come, first-serve basis, the closer to March 1 your products arrive the better the chances for a longer cure time prior to accelerated testing.

This year we will again have four testing groups. We will have one group for inorganic zinc-rich systems, one for organic zinc-rich systems, one for brushed systems and finally an experimental group that will concentrate on low VOC systems. (See the procedures for sample submission for a more detailed description.) We would like to test all systems that are currently on the Michigan Qualified Products List.

Due to the number of samples we receive, strict enforcement of the sample submission procedures is now required. In the past we have been somewhat lenient in the interpretation or enforcement. We no longer have that luxury, and any reason to reduce the size of the program is adequate to eliminate a system. Be careful! Pay particular attention to the required product information forms. If there is any question concerning these required procedures, I urge you to call me at (517) 322-1632.

Sincerely,

Gary L. Tinklenberg
Laboratory Scientist
Coatings, Sealers & Plastics

Attachments

Requirements for Sample Submission
for the 1986 Bridge Paint
Testing Program

Requirement for all groups:

1. All products must be from the standard product line of the submitting company, e.g., special products just for Michigan are not allowed.

2. A history of good field performance and/or accelerated test results must be supplied for any product not previously tested in the Michigan program.

3. A completed product information form is to be submitted for each product (a blank form is attached). This form is required every year, even if the product has been previously tested.

4. All products must be lead and chromate free, except for trace amounts in driers.

5. All intermediate coats shall be white where possible.

6. Topcoats may be any color, light blues are preferred.

7. Airless spray techniques with large production equipment are used in Groups 1, 3, and 4, therefore, sample must be a minimum of four gallons for each product. If the same product is used in different groups, please only send one four-gallon sample per product. Group 2 products will be brush applied, two gallon samples of each product will be adequate. One- or two-gallon kits are preferred for ease of handling, five-gallon samples will be accepted (however, not joyfully). Only send enough to make four gallons of mixed paint, e.g., not four two-gallon kits.

Specific Requirements for Group 1

Group 1 products are for Michigan Total Shop application specifications. All products are applied over a near-white, SSPC-10, blasted, hot-rolled carbon steel.

1. The primer must meet the SSPC definitions for an inorganic zinc-rich coating.

2. The intermediate and topcoats must be epoxy and urethane, respectively. (We will test a limited number of vinyl intermediate with vinyl topcoats. If you wish to have your vinyl system included, please contact Gary L. Tinklenberg at (517) 322-1632 or Bryon Beck at (517) 322-1652.)

3. Single, two-component inorganic, or both may be submitted for evaluation. (Only one of each, however.)

Specific Requirements for Group 2

Group 2 products are used for the spot repair of old red lead alkyd systems. The failed areas are blasted to a commercial blast, SSPC-6, the blasted area primed and the entire structure topcoated.

1. The system must be brushable.

2. The system can be any number of coats, but must be at least two.

3. The vehicle may be any type, however, it must be compatible with old, exposed red lead alkyd systems.

Specific Requirements for Group 3

Group 3 products are used for field painting existing structures which have been completely blasted to a near-white SSPC-10.

1. The primer must meet the SSPC definitions for an organic zinc-rich primer.

2. The system must contain an epoxy or urethane intermediate and a urethane topcoat.

Specific Requirements for Group 4

Group 4 is an experimental product group. This year we will give priority to low VOC type systems. There are no restrictions, but we can only test a limited number of systems due to test equipment capacity. A submission to this group does not necessarily mean it will be tested.

PRODUCT INFORMATION SHEET

PRODUCT: _____ PANEL NUMBER: _____

SUPPLIER: _____ REPRESENTATIVE: _____

GENERIC TYPE: _____

DATE REQUESTED: _____ DATE RECEIVED: _____ QUANTITY: _____

USE: _____

PRIMER OR TOPCOAT: _____

APPLICATION DATA:

Recommended DFT _____ mils Vol. Solids _____ % Recommended WFT _____ mils

Thinner _____ Generic Type _____ Thinning Limits _____ %

APPLICATION: Method: _____ Tip Size: _____ Tip Pressure: _____

COST DATA:

$/gallon: _____ mil sq ft/gal (theoretical) _____ $/sq ft at Rec. DFT _____

APPLICATION SUMMARY:

Mixing: _____

Settling: _____

Spray or Brush: _____

Sag or Mudcracking: _____

Dry Spray: _____

REMARKS: AVG DFT PRIMER _____

AVG DFT TOPCOAT(S) _____

ACCELERATED WEATHERING SUMMARY:

Test	Panel #	DFT	
Salt Fog:			1000hr ___ 2000hr ___ 3000hr ___ 4000hr ___ 5000 hr ___
UVCON:			1000hr ___ 2000hr ___ 3000hr ___ 4000hr ___ 5000hr ___
Humidity:			1500hr ___ 3000hr ___ 4500hr ___ 6000hr ___ 7500hr ___
W.C.:			2 cycles ___ 4 cycles ___ 6 cycles ___ 8 cycles ___ 10 cycles ___
Outside:			1 year ___ 2 years ___ 4 years ___ 7 years ___ 10 years ___

WEATHERING REMARKS:

_____

_____

_____

_____

_____

_____

REMARKS: _____

_____

_____

APPENDIX B

APPLICATION EVALUATION

Mixing - During the mixing of the products, they are evaluated on a 1 to 10 scale in accordance with the Mixing Evaluation definitions.

Sagging - Products are evaluated by using a modification of the Hegman grind gage. The gage is 12 in. long and 2-1/2 in. wide. In the middle there is a 1-in. wide groove that tapers from 30 mils deep to nothing. Products are drawn down, let set for 10 seconds and the gage turned on its side for 30 seconds. The sag is then recorded as that point where the product drips out of the groove. It is evaluated in accordance with Sag Evaluation definitions.

Sprayability or Brushability - During the spraying or brushing of the products, they are evaluated on a 1 to 10 scale in accordance with the Sprayability/Brushability definitions.

Settling - During the application of the products, they are evaluated on a 1 to 10 scale in accordance with the Settling definitions.

Mixing Definitions

10. One component - little or no settling - easily mixed by hand.

9. Some settling but still easily mixed by hand - one component.

8. One component - mixes easily with mechanical agitation typically in less than 30 seconds with a 3/8-in. drill motor and a Jiffy mixer. (Use 1/2-in. drill motor and larger Jiffy mixer for sample sizes greater than 1 gallon.)

7. One component - mixes with some difficulty - typically requiring less than 3 minutes per sample. Two component - both components and their blend mix easily (as defined in 8).

6. One component - mixes with difficulty (more than 3 minutes) - settled layer about 1-in. thick or very thick hard to agitate. Thin on top requires care so as not to splash out of can. Two component - components settled and mixed as in 7 blend mixes easily.

5. Two component - one of the components mixes with difficulty as in 6. Settles in 10 to 30 minutes after mixing, agitation a must.

4. Two component system - one of the components a powder, one component or one of the components extremely thick - first must break up by hand then mix with power equipment. Two component - both components mix with difficulty as in 6.

3. Multi-component systems - one of the components is a powder.

2. Multi-component - one a powder, one or more of the liquid portions difficult to mix (as in 6).

1. Badly settled - cannot redisperse with normal job site mixing equipment.

Sag or Mud Cracking Characteristics

10. Sag resistance or mud cracking limit at least 3 times the required WFT.

9. Sag resistance or mud cracking limit at least 2 times the required WFT.

8. Sag resistance or mud cracking limit at least 1.5 to 2 times the required WFT.

7. Sag resistance or mud cracking limit within 3.5 to 5 mils the required WFT.

6. Sag resistance or mud cracking limit within 2 to 3.5 mils the required WFT.

5. Sag resistance or mud cracking limit within 1 to 2 mils the required WFT.

4. Sag resistance or mud cracking limit within 1 mil the required WFT.

3. Sag resistance or mud cracking limit at the required WFT.

2. Sags at 75 percent of needed WFT.

1. Sags at half of needed WFT.

Atomization - Spray Patterns

10. Good Atomization - Excellent definition to spray pattern - No runs or sags if sprayed on in one pass - No mist coating required - Easy to control film build - No plugging - Positive shut off - No drips on gun.

9. Good Atomization - Good definition to spray pattern - No runs or sags if sprayed on in one pass - Mist coating required. Easy to control film build. No plugging, some paint on duckbill, but no problems.

8. Atomizes well - but lacks some definition of spray pattern - less than two plugs per gal - some paint on duckbill but no problems on account of it. Adequate mist coat easy to apply - less than 5 minutes between coats (mist and full).

7. Atomizes ok - occasional plugging (2 to 4 per gal). - Duckbill requires an occasional wiping - Good control of mist coat a must.

6. Atomizes but poor definition to spray pattern - some plugging (more than 4 per gal) - Drips from duckbill becoming a nuisance.

5. Poor atomization with airless, but levels ok - plugging a nuisance more than 7 per gal - Adequate mist coating difficult due to poor atomization. Some gassing inevitable.

4. Poor atomization - levels matted (bumpy) - Adequate mist coat impossible. Gassing impossible to eliminate.

3. Cannot be sprayed airless due to numerous gun plugs or plugging of the filter.

2. Can be sprayed conventionally with special equipment.

1. Cannot be sprayed airless or conventional.

Brush Characteristics

10. Good leveling - at coverage (vertical) also a recommended DFT no brush marks - no runs, no sags - even at twice the required WFT film thickness.

9. Good leveling - coverage (vertical) also gives recommended DFT. No runs or sags - even at 1.5 times the required WFT.

8. Normal or typical brushing covers and gives recommended DFT - runs or sags between 1.2 and 1.5 times the required WFT - Some brush marks noticeable.

7. Must work at it to obtain the required WFT - requires a conscious effort - some drips if not careful - paint loads up heel of brush, but does not run out of bristles.

6. Normal brushing produces a film 50 to 75 percent of specified - but with effort acceptable results are obtained. Some problem with runs and drips.

5. Normal brushing covers but produces a film 25 percent of recommended DFT. Brush "pull" hard - poor flow out when brushing veritcally hard to stop drips and runs - Covers in one coat but the necessary film build for coverage is higher than recommended DFT.

4. Cannot build in one coat to required DFT - Drips and runs a nuisance.

3. Will cover in one coat but extremely difficult to control runs.

2. Will not cover in one coat in vertical position - covers in one coat in horizontal position but sags when tipped to vertical.

1. Will not cover in one coat even in horizontal position.

Settling Characteristics After Mixing

10. No agitation required after mixing.

9.

8. No agitation in supply can, but settles overnight.

7. Agitation may be required - some settling in 4 hours.

6. Agitation required - some settling in 2 hours, but no noticeable settling in 1/2 hour.

5. Settles in 10 to 30 minutes similar to ASTM-D-869-8; easily redispersed with stirring rod.

4.

3. Settles in 10 to 30 minutes similar to ASTM-D-869-6; need mechanical agitation to redisperse.

2.

1. Falls out of suspension immediately.

PERFORMANCE TEST PROCEDURES

Salt Fog - ASTM B-117, w/scribed panels. Panels are evaluated every 1000 hours.

Envirotest - The envirotest is an experimental piece of equipment; therefore, there is no ASTM standard procedure. The chamber has a paddle wheel configuration that makes one revolution every four hours. The top of the chamber is heated to 120 F and contains an ultraviolet light source. The bottom contains enough 3 percent NaCl solution to cover the panels for 80 minutes each rotation. Panels are evaluated every 1000 hours.

UV Con - ASTM G-53, w/scribed panels. Panels are evaluated every 1000 hours.

Weather Cycle - One cycle consists of:

Five freeze-thaw cycles. One cycle consists of panels immersed about half-way in distilled water and placed in a -20 F freezer overnight. After 16 hours they are placed in a 120 F oven for eight hours (forced air oven).

200 hours in the UV Con (G-53).

50 hours in the salt fog (B-117).

Panels are evaluated after two complete cycles.

100 Percent Humidity - Panels are placed in a concrete curing room, temperature 77 F, humidity 100 percent. Panels are evaluated every 1500 hours.

Outside - Panels are scribed and mounted at a 45° angle, facing south in a semi-rural area.

Salt Fog and Envirotest

Salt Fog and Cyclic Envirotest Chamber - The panels are evaluated by averaging three ratings. The ratings are: the scribe area rating, the blistering (ASTM D-714) of the area above the scribe, and the rust (ASTM D-610) in the area above the scribe.

Scribe Area

10. No Rust - No Blisters.

9. Slight Rust - Slight Lifting - No Stains.

8. Rust - Stain streaks from end of scribe - Blistering 1/4 in. total along scribe.

7.5. Rust - Stain streaks along both legs of scribe.

7. Rust - Slight build up - Stain streaks along entire scribe - 1/4 in. on each side of scribe blistered.

6. Rust - Build up in scribe - 1/2 in. on each side of scribe - Adhesion failure between coats, lifting along scribe area, but less than 1/2 of scribe area.

5. Rust - Heavy build up in scribe - 1/2 in. or less of scribe area blistered or rusted, but at least one quadrant.

4. Major portion of scribe area rusted or blistered.

3. Entire scribe area rusted or blistered.

2. Rusted or blistered except 1/4 in. around edge of panel.

1. Entire bottom half of panel completely rusted.

UV Con

	Top	Scribe Area
10.	No rust No blistering No chalking	No rust No lifting at scribe No scribe rust
9.	No rust No blistering Slight chalking	No rust Some lifting Slight chalking Scribe rust
8.	No rust No blistering Chalked	0.1 percent rust (8 or 9) Some lifting Slight blistering
7.	No rust Slight blistering Slight cracking in topcoat 1 in. total length	0.3 percent rust (7) Lifting-Starting to curl Blistering
6.	0.1 percent rust ASTM (8 or 9) Slight blistering Chalking Cracking in topcoat 1 to 4 in.	1 percent rust 6 - Topcoat Breaking up along scribe
5.	Entire surface mud cracked 1 percent ASTM 6 or 7 Blistering Topcoat cracked (Total length of cracks more than 4 in.)	Scribe area 50 percent Delaminated 3 percent rust (5)
4.	25 percent of topcoat delaminated 1 percent ASTM 6 or 7 Cracking in topcoat - Open and delaminated back to 1/8 to 3/8 in.	Totally delaminated, but very little rust. 10 percent rust (4)
3.	50 percent of topcoat delaminated 3 percent ASTM 5 Cracks open more than 3/8 in. 75 percent of topcoat delaminated	Totally delaminated Rust in X area 16 percent rust (3)
2.	3 percent ASTM 5 Severe blistering - Delamination almost complete	50 percent rust (2)
1.	Rust rating 4	Completely rusted

Weather Cycle

10. Perfect.

9. No Rust. Some small blisters (9 or 8 from Humidity Definitions) below waterline - Slight chalking - Pinhole rust 9 below waterline.

8. No Rust. Blister (6 or 7) below waterline - (7, 8, 9) above waterline 9 or 8 rust rating.

7. 7 or better Rust Rating, blistering pronounced, but very little if any rust 2 few below - Topcoat breaking up undercoats solid.

6. 7 or better Rust Rating, delmaination below waterline but no rust. Some blisters starting to rust - 2 Med below.

5. 5 or better Rust Rating - delamination below or above waterline and 7 or better rust rate.

4. Total delamination above or below waterline, but no rusting - 4 Rust Rating.

3. Total delamination some rusting - top totally gone and rusted submersed good - 3 Rust Rating.

2. Total delamination and considerable rusting below immersion line - 2 Rust Rating.

1. 1 Rust Rating.

Humidity

10. Perfect, no rust, no blisters, no lifting.

9. Blistering A Few Size 8,
No blisters slight scribe rust and 8 - 9 blisters along scribe only.

8. Blistering Size 6 Few or 8 Med
Slight scribe rust 6 - 7 blisters along scribe.

7. Blistering Size 4 Few or 6 Med or 8 Med Dense,
ASTM Rust Rating 9, 4 - 5 along scribe only.

6. Blistering Size 2 Few or 4 Med or 6 Med Dense or 8 Dense
ASTM Rust Rating 7 - 8.

5. Blistering Size 2 Med or 4 Med Dense or 6 Dense
ASTM Rust Rating 5 and 6 - Lifting 1/4 in. either side of scribe.

4. Blistering Size 2 Med Dense or 4 Dense
ASTM Rust Rating 4

3. Bistering Size 2 Dense
   ASTM Rust Rating 3.

2. ASTM Rust Rating 2 and 1.

1. Completely rusted.

		Frequency			
		Few	Medium	Medium Dense	Dense
S	8	9	8	7	6
I	6	8	7	6	5
Z	4	7	6	5	4
E	2	6	5	4	3

Outside Rating

10. Perfect.

9. Small amount of scribe rust - slight chalking.

8. Rusted scribe - moderate chalking.

7. Lifting or blistering along scribe - 1/8 in. - D-714 rating of 8.

6. Lifting or blistering along scribe - 1/4 in. - D-714 rating of 6, D-610 rating of 8.

5. Lifting or blistering along scribe - 1/2 in. - D-714 rating of 4, D-610 rating of 6.

4. Majority of scribe area lifted or blistered - D-714 rating of 2, D-610 rating of 5.

3. Entire scribe area rusted or blistered - D-610 rating of 4.

2. D-610 rating of 3.

1. D-610 rating of 2.

EVALUATION PROCEDURES

All performance tests have five evaluation periods. The time in each period varies depending on the test. In all cases the performance rating in an individual test is a time weighed rating, as follows:

40 percent of the fifth rating + 25 percent of the fourth rating + 17.5 percent of the third rating + 12.5 percent of the second rating + 5 percent of the first rating = Performance in a particular test.

These are the values listed under the abbreviation for the accelerated test.

The Overall Performance Rating (listed below OVERALL on the computer printout) is a combination of the individual performance test rating on a test weighted basis, as follows:

> 30 percent of the salt fog rating + 20 percent of the Envirotest Rating + 10 percent of the UV CON Rating + 15 percent of the Humidity Rating + 20 percent of the Weather Cycle Rating + 5 percent of the Outside Rating = The Overall Performance Rating.

The system rating is a combination of the overall performance rating and the overall application rating as follows:

> 40 percent of the Overall Application Rating + 60 percent of the Overall Performance Rating = System Rating.

The overall application rating is an average of the product application ratings. The product application rating is a test weighted average, as follows:

> 20 percent of the Mixing Rating + 30 percent of the Sag Rating + 40 percent of the Sprayability/Brushability Rating + 10 percent of the Settling Rating = The Product Application Rating.

APPENDIX C

MICHIGAN
DEPARTMENT OF TRANSPORTATION

John P. Woodford, Director

SPECIAL PROVISION FOR SHOP CLEANING, SHOP PRIMING, FIELD REPAIR AND TOP COATING STRUCTURAL STEEL (2-COAT SYSTEM)

DESCRIPTION:

This work shall consist of the complete blast cleaning and coating of the metal surfaces with an inorganic zinc rich primer in the shop, field repair of primer, and the field topcoating.

The work shall be done in accordance with the 1979 Standard Specifications for Highway Construction except as otherwise provided in the proposal.

MATERIALS:

The primer coating shall be one of the following products: Mobilzinc Uni-Pac 13-G-10W, Dimetcoat EZ-II, or Carbo-Zinc SP-76. (Supplier information is listed at end of Special Provision). The coating for the topcoat shall be manufactured by the supplier of the inorganic zinc primer. It shall consist of vinyl, epoxy, or urethane resins dissovoled in suitable solvents. It shall be well ground and shall not be caked, livered, skinned, or badly settled in the container. The coating shall be capable of being applied at a 3.5 mil dry film thickness in one coat.

The color for the topcoat shall be Color Number _____. If the manufacturer recommends a tie coat for use with this color, it shall be applied according to his recommendations.

CLEANING OF STRUCTURES:

The surfaces to be coated shall be free of all oil and grease and then blast cleaned to a "near white" finish which is defined as follows:

> A finish from which all paint, oil, grease, dirt, mill scale, rust, corrosion products, oxides, or any other foreign matter have been removed except for very slight shadows, very slight streaks, or slight discolorations; at least 95% of each square inch of the surface shall have the appearance of a surface blast cleaned to a white metal finish and the remainder shall be limited to the light discolorations mentioned above (for reference, see NACE No. 2 or SSPC-SP10-63).

Care must be taken to protect freshly coated surfaces from blast cleaning. Blast damaged primer surface shall be thoroughly wire brushed or if visible rust occurs, reblasted to a near white condition and reprimed.

All fins, tears, or slivers that are present or appear during the blasting operation shall be removed by grinding and the area reblasted to give a good (2 mil) surface profile.

Scaling hammers are permissible to remove heavy scale, but heavier type chipping hammers that would excessively scar the metal shall not be used.

Abrasives used for blast cleaning shall be either clean dry sand, steel shot, mineral grit, or manufactured grit meeting the following requirement:

> The gradation of the abrasives shall be such that they product a uniform 1 to 2 mil profile as measured with Testex Replica Tape.

All sand and paint residue shall be removed from all the exposed steel surfaces before any coating is applied. The steel shall be blown with clean dry air followed by vacuuming with a good commercial grade vacuum cleaner equipped with a brush type cleaning tool. The vacuum cleaned steel shall be primed within 8 hours after blast cleaning. After the steel is primed, it shall be vacuumed again before topcoating. If for any reason this vacuuming does not remove all the accumulated dust and/or dirt, or if in the opinion of the Engineer the surface is unfit for topcoating, the surface shall be scrubbed with a mild detergent solution (any commercial laundry detergent) and thoroughly rinsed with water before the surface is topcoated.

COATING OF STRUCTURES:

After the entire surface to be coated has been cleaned and approved by the Engineer, the primer shall be applied so as to produce a uniform even coating bonded with the metal. Succeeding coats shall also be so applied. All coating must be done in a neat and workmanlike manner as outlined in SSPC-PA 1-64.

Mixing the Coating. - The coating shall be mixed with power equipment in accordance with the producer's directions to a smooth, lump free consistency. Mixing shall be done as far as possible in the original containers and shall be continued until all of the metallic powder or pigment is in suspension.

Prior to straining through a 50 mesh (max) screen to remove any foreign particles, care must be taken to insure that all of the coating solids that may have settled to the bottom of the can are thoroughly dispersed. After straining, the mixed material shall be kept under continuous agitation up to and during the time of application.

Thinning the Coating. - The coating when thoroughly mixed is ready for use. If it is necessary in cool weather to thin the coating so that it can be properly applied it shall be done only in accordance with the producer's recommendations.

Application of the Coating. - The coating shall be applied only when the air and steel temperatures are above 40 degrees F. It shall not be applied when the relative humidity is greater than 85% or when a combination of temperature and humidity conditions are such that moisture is condensing upon the surface to be coated. If there is any doubt that the above conditions are being met, the following test shall be performed:

A small area is moistened with a damp cloth so as to apply a clearly defined, thin film of water. If this film evaporates within 15 minutes, the surface shall be considered safe to coat.

Coating shall not be permitted when surface temperatures are high enough to cause blistering.

A minimum of two days of proper drying conditions shall be required between the application of the primer and the topcoat.

Coating Thickness. - The dry film thickness of the primer shall be not less than 2-1/2 mils and of the topcoat not less than 3-1/2 mils as determined by the Engineer using a magnetic film thickness gauge. If running and/or sagging occurs when the coatings are spray applied in one coat, the coating shall be applied in multiple passes of the gun separated by several minutes. Where excessive primer thickness causes "mud-cracking", the coating material shall be scraped back to soundly bonded coating and the area re-coated to a minimum of 2-1/2 mils.

The Engineer will inspect each section of steel before it is coated. The contractor shall furnish and erect scaffolding to the satisfaction of the Engineer to facilitate a safe inspection of all cleaned areas and be afforded every opportunity to check the film thickness of each coat applied. If an area is approved for priming or topcoating, the contractor then may coat the area.

Metal rollers or clamps and all other fastening devices for scaffolds and equipment attached to the structural steel which will mar or damage freshly coated surfaces will be prohibited. It will be required that rubber rollers or other protective devices, as approved by the Engineer, be used on scaffold fastenings for the purpose of protecting the freshly coated surfaces.

FIELD REPAIR:

When erection work is complete including all connections and straightening of bent metal, all adhering scale, dirt, grease, or other foreign matter shall be removed by appropriate means. Any rusted areas shall be reblasted to a near white (as defined in this Special Provision). The coating surrounding the blasted area shall be shoroughly wire brushed and the area reprimed, with the same primer used in the shop, to a dry film thickness of 2.5 mils.

Galvanized bearings shall be coated in accordance with the recommendations of the manufacturer of the coating system. This procedure shall include the removal of any residuals on the surface and the application of a wash primer or tie coat prior to the application of the topcoat. All costs for this work shall be considered incidental to the cost of Field Painting.

PROTECTION OF WORK:

Pedestrian and vehicular or other traffic upon or underneath the structures shall be protected as provided in Section 1.05.13 of the 1979 Standard Specifications for Highway Construction. All portions of the structures (superstructure, substructure, slope protection, and highway appurtenances) shall be protected against splatter, splashes and smirches of coating, or coating material by means of protective covering suitable for the purpose. Similar protection shall be afforded any highway appurtenances that could be damaged by blast cleaning operations. The contractor shall be responsible for any damage caused by his operations to vehicles, persons, or property.

During blast cleaning operations, provisions must be made by the contractor to protect existing traffic from any hazards resulting from the blast cleaning operations. These provisions shall include a type of barrier system which would protect against direct blasting of vehicles or pedestrian, eliminate abrasive materials and debris from falling on the traveled portions of the pavement, and prevent the spreading of abrasive materials and debris in the area which would create a traffic hazard. At the pre-construction meeting, the contractor must submit a plan detailing the method of protection to be used.

Whenever the intended purposes of the protective devices are not accomplished, work shall be suspended until corrections are made. In addition, any abrasive material and debris deposited on the pavement, shoulders, or slope paving in the working area must be removed before those areas are reopened to traffic.

Employees performing the blast cleaning operations shall be provided with a air-supplied sand blasting hood approved by the U. S. Bureau of Mines. The air supply system shall include, but not be limited to the following approved safety features: (Air line filter, pressure reducing valve with gauge, and pressure release valve). Air supply to the employees shall not be contaminated with harmful materials or elements.

MEASUREMENT AND PAYMENT:

The completed work as measured for Shop Cleaning, Shop Priming, Field Repair and Top Coating Structural Steel will be paid for at the contract unit price for the following contract items (Pay Item):

Pay Item	Pay Unit
Field Painting	Lump Sum

"Field Painting" shall be measured as a unit for each structures.

Cleaning and Priming of Structural Steel shall be included in the cost of "Structural Steel, Furnishing and Fabricating."

APPENDIX D

APPENDIX D

The problems associated with the shop prime - field topcoat specifications are too numerous and lengthy to be contained in the body of this report. They developed over a span of three years on approximately 40 structures. The major problems were:

1) Responsibility for damage. The repair of an inorganic zinc-rich primer is quite time consuming. Therefore, costs were determined based on the amount to be repaired. The painting contractors always estimated less than what was required or underestimated the amount of cleaning necessary prior to topcoating. On many occasions everyone blamed the other contractors for the problems.

2) Determining the amount of damage prior to the bid. Obviously the amount of damage to the primer was an important variable in submitting a bid. The contractor who underestimated (e.g., guessed wrong) was always given the bid. The system generates its own problems.

3) Form oil. Many decks were formed with wood forms that had to be treated with form oil. This oil leaked through the seams and dripped on the primer. It is very difficult to remove. Many times it was not removed, causing early failure of the topcoat.

4) Dirt. Site storage often led to large areas being coated with mud. Its removal is difficult and, therefore, expensive. It is also impossible to estimate the cost of cleaning until just before the cleaning is required, long after the bid was submitted.

5) Road salts. If primed structures are erected over traffic and allowed to remain untopcoated over a Michigan winter, they become heavily contaminated with salt. To get this salt adequately removed without a substantial claim from the contractor was nearly impossible.

6) Handling. Everyone handled the steel with little concern about the primer. The reason no one was concerned was that it had to be painted anyway. This resulted in many damaged edges and numerous small abrasions of the primer.

All of these problems contributed to the general Department frustration with this system. It was abolished in 1983.

APPENDIX E

MICHIGAN
DEPARTMENT OF TRANSPORTATION
BUREAU OF HIGHWAYS

SUPPLEMENTAL SPECIFICATION
FOR
COMPLETE SHOP COATING OF STRUCTURAL STEEL
AND
FIELD REPAIR OF DAMAGED COATING
TYPE 3

a. Description.-This specification covers the shop cleaning and the shop application of a complete coating system on new structural steel; this work is included in the work of furnishing and fabricating structural steel. This specification also covers the field cleaning and repair of surfaces damaged in shipping, handling, and erecting the structural steel; this work will be paid for as Field Repair of Damaged Coating.

The coating system shall consist of a coat of zinc-rich primer, a coat of high-build epoxy, and a urethane protective coat.

Terminology used herein is in accordance with the definitions used in Volume 2, Systems and Specifications, of the SSPC Steel Structures Painting Manual (1982 Edition).

The work shall be done in accordance with the 1984 Standard Specifications except as otherwise specified herein.

b. Materials:

1. Coating System.-The Contractor shall select a complete coating system from one of the approved coating systems listed in the attached Qualified Products List (QPL), or from the Research Laboratory. The color for the epoxy coating material shall be white. The color for the urethane protective coat shall match color number 15200 of Federal Standard Number 595a, dated January 2, 1968. The Contractor shall supply the Engineer with the product data sheets before any coating is done. The product data sheets shall indicate the mixing and thinning directions, the recommended spray nozzles and pressures, the minimum drying time for shop applied coats, and the recommended procedures for coating galvanized bearings, bolts, nuts, and washers.
2. Chrome Plating.-Hanger pins shall be completely hard chrome plated to a minimum thickness of 3 mils. The surface finish on the chromed pins shall be less than 20 micro inches root mean square (rms) on the bearing surface and less than 125 micro inches root mean square (rms) on the ends.
3. Zinc Coatings.-Position dowels and anchor bolts, including nuts and washers, shall be hot-dip galvanized in accordance with ASTM A153. Galvanized nuts shall be tapped oversize in accordance with the requirements of ASTM A563 and shall meet the requirements of Supplementary Requirement S1 of ASTM A563, Lubricant and Test for Coated Nuts. Excess hot-dip galvanizing on threaded portions shall be removed by centrifuging or air blasting immediately upon withdrawal; flame chasing is prohibited.

   All portions of bearings not welded to the beam or girder and other structural members and parts required to be zinc coated shall be galvanized

in accordance with ASTM A123. Fabricated bearing components shall be blast cleaned to remove all mill scale prior to galvanizing.

c. Provisions for Inspection.-During fabrication and shop coating, scaffolding shall be furnished and erected meeting the approval of the Engineer to permit inspection of the steel prior to and after coating.

Rubber rollers, or other protective devices meeting the approval of the Engineer, shall be used on scaffold fastenings. Metal rollers or clamps and other types of fastenings which will mar or damage freshly coated surfaces shall not be used.

d. Preparation for Shop Coating.-All areas of oil and grease on surfaces to be coated shall be cleaned with clean petroleum solvents and then all the surfaces to be coated shall be blast cleaned to a near-white finish in accordance with SSPC-SP 10 (page 47, Volume 2).

All fins, tears, slivers, and burred or sharp edges that are present on any steel member, or that appear during the blasting operation, shall be removed by grinding and the area reblasted to give a 1 to 2-mil surface profile.

Scaling hammers may be used to remove heavy scale but heavier type chipping hammers which would excessively scar the metal shall not be used.

Abrasives used for blast cleaning shall be either clean dry sand, steel shot, mineral grit, or manufactured grit and shall have a gradation such that the abrasive will produce a uniform profile of 1 to 2 mils, as measured with Testex Replica Tape.

All abrasive and paint residue shall be removed from steel surfaces with a good commercial grade vacuum cleaner equipped with a brush-type cleaning tool, or by double blowing. If the double blowing method is used, the top surfaces of all structural steel, including top and bottom flanges, longitudinal stiffeners, splice plates, hangers, etc., shall be vacuumed after the double blowing operations are completed. The steel shall then be kept dust free and primed within 8 hours after blast cleaning.

Care shall be taken to protect freshly coated surfaces from subsequent blast cleaning operations. Blast damaged primed surfaces shall be thoroughly wire brushed or if visible rust occurs, reblasted to a near-white condition. The wire brushed or blast cleaned surfaces shall be vacuumed and reprimed.

All areas where field welding is required, except the areas where the stud shear connectors will be welded to the top flange, shall be masked prior to shop coating. Areas where stud shear connectors will be welded to the top flange shall be masked after the primer coat has been applied, but before the epoxy coat is applied.

e. Mixing the Coating.-The coating shall be mixed with a high shear mixer (such as a Jiffy Mixer), in accordance with the producer's directions, to a smooth, lump-free consistency. Paddle mixers or paint shakers are not allowed. Mixing shall be done, as far as possible, in the original containers and shall be continued until all of the metallic powder or pigment is in suspension.

Care shall be taken to ensure that all of the coating solids that may have settled to the bottom of the container are thoroughly dispersed. The coating shall then be strained through a screen having openings no larger than those specified for a No. 50 sieve in ASTM E 11. After straining, the mixed primer shall be kept under continuous agitation up to and during the time of application.

f. Thinning the Coating.-In general the coatings are supplied for normal use without thinning. If it is necessary to thin the coating for proper application in cool weather or to obtain better coverage of the urethane protective coat, the thinning shall be done in accordance with the manufacturer's recommendations.

g. Conditions for Coating.-The coating shall only be applied when the following conditions have been met:

1. Temperature.-The temperature of the air and the steel shall be above 50 F but shall not be so hot as to cause blistering of the coating.
2. Humidity.-The coating shall not be applied when the relative humidity is greater than 90 percent nor when a combination of temperature and humidity conditions are such that moisture condenses on the surface being coated. A minimum of 50 percent is required during the curing time of the inorganic type primers.

h. Applying the Coating.-After the surface to be coated has been cleaned and approved by the Engineer, the primer shall be applied so as to produce a uniform even coating bonded with the metal. Succeeding coats shall be applied when approved by the Engineer. The minimum curing time between coats is listed in the attached Qualified Products List. Depending on site conditions, additional time may be required for proper curing before applying succeeding coats. It is the applicator's responsibility to determine if the coating has cured sufficiently for proper application of succeeding coats. No more than 60 calendar days will be permitted between coats. If this limit is exceeded, all newly coated surfaces shall be hand sanded and wiped or blown clean prior to the next coat.

The coatings shall be applied with the spray nozzles and pressures recommended by the producer of the coating system, so as to attain the film thicknesses specified. Surfaces to be coated include faying (contact) surfaces of bolted field splices. The dry film thickness of the primer coat on the bolted friction splices on the main members and on the top of top flanges where the stud shear connectors are to be welded, shall not be less than 1 mil or greater than 2.5 mils. The faying surfaces of bolted field splices, bolted shop splices, or any other bolted faying surfaces, and the top of top flanges where the stud shear connectors are to be welded shall be masked during subsequent coating operations. In the areas of field bolted connections (including the outside surface of splice plates) the outside surfaces shall be primed (minimum 2.5 mils) only. On all other areas, the minimum dry film thickness for the primer coat shall be 2.5 mils, for the epoxy coat shall be 3.5 mils, and for the urethane protective coat shall be sufficient to provide a uniform color and appearance but in no case less than 1.0 mil. The dry film thickness will be determined by the use of a magnetic dry film thickness gage. The gage shall be calibrated on the blasted steel with plastic shims approximately the same thickness as the minimum dry film thickness. A Tooke film thickness gage may be used to verify the coating thickness when requested by the Engineer. If the Tooke gage shows the primer coat to be less than the specified minimum thickness, the total coating system will be rejected even if the total dry film thickness exceeds the 7.0-mil minimum for a 3-coat system.

All bolted shop connections and bolted cross frames or diaphragms shall be removed and disassembled prior to the blasting and coating of the girders or beams. The parts shall be blasted separately and primed, then reassembled and the bolts fully tightened.

All galvanized components, including galvanized nuts, bolts, and washers, shall be solvent cleaned, given a tie coat, and then coated with both the epoxy coat and the urethane protective coat.

If the application of the coating at the required thickness in one coat produces runs, bubbles, or sags, the coating shall be applied in multiple passes of the spray gun, the passes separated by several minutes. Where excessive coating thickness produces "mud-cracking," such coating shall be scraped back to soundly bonded coating and the area recoated to the required thickness.

In areas of deficient primer thickness, the areas shall be thoroughly cleaned with power washing equipment, as necessary to remove all dirt; the areas shall then be wire brushed, vacuumed, and recoated.

All coating shall be done in a neat and workmanlike manner as described in SSPC-PA1, producing a uniform, even coating which is bonded to the underlying surface.

Erection marks, for the field indentification of members, and weight marks shall be transferred or preserved.

All metal coated with impure, unsatisfactory, or unauthorized coating material, or coated in an unworkmanlike or objectionable manner, shall be thoroughly cleaned and recoated or otherwise corrected as directed by the Engineer.

All dry spray shall be removed, by sanding if necessary, prior to the application of the succeeding coat.

Material shall not be loaded for shipment until the shop coating has adequately cured and been inspected. The components will be stamped "Recommended for Use" only after the loading has been completed and approved.

i. Stenciling Requirement.-At the completion of the shop coating, the completion date (month and year) and the number of the type of coating system used shall be stenciled on the inside of the facia beams, at the locations designated by the Engineer, in 4-inch numbers; for example: 6/85-3. The paint used for this marking shall be the same as the urethane coat except the color shall be black.

j. Handling Steel.-Extreme care shall be exercised in handling the steel in the shop, during shipping, during erection, and during subsequent construction of the bridge. The steel shall be insulated from the binding chains by softeners approved by the Engineer. Hooks and slings used to hoist steel shall be padded. Diaphragms and similar pieces shall be spaced in such a way that no rubbing will occur during shipment that may damage the coatings. The steel shall be stored on pallets at the job site, or by other means approved by the Engineer, so that it does not rest on the dirt or so that components do not fall or rest on each other. All shipping and job site storage details shall be presented to the Engineer at the pre-fabrication meeting and they must be approved prior to shipping the steel.

k. Field Repair.-The Contractor shall furnish and erect scaffolding meeting the approval of the Engineer and shall provide a time mutually agreed to for inspecting the structural steel prior to and after coating.

Rubber rollers, or other protective devices meeting the approval of the Engineer, shall be used on scaffold fastenings. Metal rollers or clamps and other types of fastenings which will mar or damage freshly coated surfaces shall not be used.

All field repairs shall be made in strict accordance with the coating supplier's recommendations and shall be approved by the Engineer. All coatings

applied to repair areas shall be applied using recommended spray equipment only. The coating supplier's recommendations are to be supplied to the field personnel by the fabricator of the steel. Such field repairs shall include the application of the following coating system; e.g. on rusted areas: the zinc-rich primer, the epoxy intermediate coat, and the urethane protective coat; on non-rusted areas (where the primer is at least equal to the minimum required dry film thickness): the epoxy intermediate coat and the urethane protective coat; and on galvanized components: the tie coat, the epoxy intermediate coat, and the urethane protective coat.

Surfaces which will be inaccessible for coating after erection shall be repaired and/or recoated prior to erection.

When the erection work has been completed, including all connections and the straightening of any bent metal, the steel shall be prepared for repairs. All adhering scale, dirt, grease, form oil, or other foreign matter shall be removed by appropriate means and any rusted or uncoated areas blast cleaned to a near-white finish in accordance with SSPC-SP 10. All abrasive and paint residue shall be removed from steel surfaces by vacuuming or by double blowing, except that if the double blowing method is used the top surfaces of all structural steel, including top and bottom flange, splice plates, hangers, etc., shall be vacuumed after the double blowing operations are completed. The coating surrounding the blasted area shall be thoroughly wire brushed, vacuumed, and the area recoated with the same coating system used in the shop. When spraying a blasted area or an area of insufficient primer thickness, the surrounding area will be coated with primer due to overspray. Prior to the application of the intermediate coat, the area around the area where the primer has been repaired shall be adequately rubbed to remove the primer from the surrounding epoxy or urethane. The requirements specified herein for provisions for inspection, mixing the coating, thinning the coating, temperature and humidity requirements for coating, and applying the coatings, shall govern the application of the coating to the repaired areas. The requirements for the dry film thickness of the repair coats are the same as for the shop coats. Proper curing conditions will be required between the application of the coatings. Minimum curing times for each product of the system are listed on the Qualified Products List. No more than 60 calendar days will be permitted between coats. If this limit is exceeded, all newly coated surfaces, shall be hand sanded prior to the next coat.

Galvanized nuts, bolts, and washers shall be coated in accordance with the recommendations of the manufacturer of the coating system. This procedure shall include the removal of any lubricant or residuals on the surface and the application of a tie coat prior to application of the field coats. This tie coat may be brushed.

Any temporary attachments or supports for scaffolding or forms shall not damage the coating system. (In particular, on the fascias where bracing is used, sufficient size support pads must be used.) Any damage that occurs from such devices shall be repaired by the same procedure as for a field repair.

If the stenciling which was applied at the completion of the shop coating is marred or damaged, the marking shall be repaired as directed by the Engineer. The paint used for this marking repair shall be the same as the urethane protective coat used in the field repairs except the color shall be black.

1. Protection of the Work.-Pedestrian, vehicular, and other traffic upon or underneath the structure shall be protected as provided under Subsection 1.05.13

of the 1984 Standard Specifications. All portions of the structures (superstructure, substructure, slope protection, and highway appurtenances) shall be protected against splatter, splashes, and smirches of coating or coating material by means of protective covering suitable for the purpose. Similar protection shall be afforded any highway appurtenances that could be damaged by blast cleaning operations. The Contractor shall be responsible for any damage caused by his operations to vehicles, persons, or property.

Whenever the intended purposes of the protective devices are not being accomplished, work shall be suspended until corrections are made. In addition, any abrasive material and debris deposited on the pavement, shoulders, or slope paving in the working area shall be removed before those areas are reopened to traffic.

m. Measurement and Payment.-The completed work of Structural Steel, Furnishing and Fabricating (of the type specified) includes furnishing, fabricating, and cleaning the structural steel; furnishing and applying the complete shop applied coating system including the stenciling and will be measured and paid for by weight in pounds in accordance with Section 5.04 of the 1984 Standard Specifications.

The completed work as measured for FIELD REPAIR OF DAMAGED COATING will be paid for at the contract unit price for the following contract item (pay item).

Pay Item	Pay Unit
Field Repair of Damaged Coating (Structure Number)	Lump Sum

Field Repair of Damaged Coating will be measured as a unit for each structure and includes making all the field repairs of the shop applied coating system including the repair of the stenciling and the coating of galvanized nuts, bolts, washers, and any other galvanized components that are not shop coated.

MICHIGAN DEPARTMENT OF TRANSPORTATION

Qualified Product List
Systems Listed in Alphabetical Order by Producer
Use: Complete Shop Coating
Type 3

Producer	Represented By:	Coats	Products	Dry Film Thickness Mils Min.	Color	Min./Time Between Coats Hrs.
Ameron, Protective Coatings Division 201 North Berry St. Brea, CA 92621	B. Marshall Same 313-886-5553	1st	Dimetcoat EZ-II	2.5	-----	16
		2nd	Amercoat 383HS	3.5	White	16
		3rd	Amercoat 450GL	1	15200	
Carboline 320 Hanley Industrial Ct. St. Louis, MO 63144	PCA, Incorporated 6315 E. 7-Mile, Suite 200 Detroit, MI 48234 313-891-2060	1st	Carbozinc 10	2.5	-----	48
		2nd	190 FD	3.5	White	12
		3rd	134	1	15200	
Dupont Maintenance Finishes Wilmington, DE 19898	Rick Mozeleski 302-772-5697	1st	Ganicin Single Package Inorganic Zinc, 347-Y-961	2.5	-----	12
		2nd	Corlar 823-Y-Line	3.5	White	4
		3rd	Imron w/V6-Y-511 Activator	1	15200	
Glidden Coatings And Resins Cleveland, OH 44115	Brad Penning 925 Euclid Ave. Cleveland, OH 44115 216-344-8208	1st	5535 I.O.Z.	2.5	-----	16
		2nd	5240 Glid-Guard Epoxy	3.5	White	4
		3rd	6200 Acrylic Urethane	1	15200	
Hempel Marine Paints, Inc. P.O. Box 3279 Wallington, NJ 07057	Jeff McKenna, Same 201-939-9411	1st	Galvosil 1581	2.5	-----	48
		2nd	Hempadur Hi-Build 4520	3.5	White	24
		3rd	Hempathane Enamel 5518	1	15200	
Sherwin Williams	Sherwin Williams 2121 South Cedar Lansing, MI 48910 517-482-5587	1st	Zinc Clad I	2.5	-----	18
		2nd	Tile Clad II	3.5	White	12
		3rd	Aliphatic Urethane	1	15200	
Tnemec Company, Inc. North Kansas City, Missouri 64116	Mich Protective Coatings Brad Brown P.O. Box 39287 Detroit, MI 48239 313-538-7878	1st	90-93 Tneme-Zinc (a)	2.5	-----	24
		2nd	Series 66 Epoxoline	3.5	White	12
		3rd	Series 72 Endura Shield II	1	15200	

(a) This primer shall not be applied on the faying surfaces of the bolted girder or beam field splices. Any of the inorganic zinc rich primers may be applied to such surfaces.

MICHIGAN
DEPARTMENT OF TRANSPORTATION
BUREAU OF HIGHWAYS

SUPPLEMENTAL SPECIFICATION
FOR
CLEANING AND COATING EXISTING STEEL STRUCTURES
TYPE 4

a. Description.-This work shall consist of the complete blast cleaning and coating of the metal surfaces of existing steel structures, including downspouts and all brackets. When the entire deck is to be removed, then the top and sides of all the top flanges shall also be blast cleaned and prime coated according to this specification. Utility conduits, including all brackets and hangers, shall also be cleaned and coated according to this specification but shall be done only when called for on the plans. This work excludes hand railings and chain link fence enclosures.

Terminology used herein is in accordance with the definitions used in Volume 2, Systems and Specifications of the SSPC Steel Structures Painting Manual (1982 Edition).

b. Coating System.-The Contractor shall select a complete coating system from one of the approved coating systems listed in the attached Qualified Products List (QPL), or from the Research Laboratory.

The color for the topcoat shall match color number 15200 of Federal Standards Number 595a dated January 2, 1968. The Contractor shall supply the Engineer with the product data sheets before any coating is done. The product data sheets shall indicate the mixing and thinning directions, and the recommended spray nozzles and pressures.

c. Cleaning of Structures.-All areas of oil and grease on surfaces to be coated shall be cleaned with clean petroleum solvents and then all the surfaces to be coated shall be blast cleaned to a near-white finish as defined in SSPC-SP10. See SSPC Visual Standards. (See Note 1).

Prior to blast cleaning a beam, the top of the bottom flange shall be scraped (with a gardon hoe, for example) to remove the accumulated dust and dirt.

All fins, tears, slivers, and burred or sharp edges that are present on any steel member, or that appear during the blasting operation, shall be removed by grinding and the area reblasted to give a 1 to 2-mil surface profile. Scaling hammers may be used to remove heavy scale but heavier type chipping hammers which would excessively scar the metal shall not be used.

The abrasive used for blast cleaning shall be an approved low dusting abrasive and shall have a gradation such that the abrasive will produce a uniform profile of 1 to 2 mils, as measured with Testex Replica Tape. (The approved abrasives are listed on page 5.) Due to surface roughness from corrosion, this method will not work on A-588 structures; thus for each lot of abrasive, the Contractor shall supply an unblasted piece of steel at least one foot square and 1/4 inch thick and blast it on site with their standard procedures. The inspector will determine the profile on this piece.

All abrasive and paint residue shall be removed from steel surfaces with a good commercial grade vacuum cleaner equipped with a brush-type cleaning tool, or by

double blowing. If the double blowing method is used, the exposed top surfaces of all structural steel, including flanges, longitudinal stiffeners, splice plates, hangers, etc., shall be vacuumed after the double blowing operations are completed. The steel shall then be kept dust free and primed within 8 hours after blast cleaning.

Care shall be taken to protect freshly coated surfaces, bridge bearing components, hand railings, galvanized fence enclosures, all appurtenances, and any adjacent concrete from blast cleaning operations. These areas shall be protected from blast cleaning operations by shielding or masking. Blast damaged primed surfaces shall be thoroughly wire brushed or if visible rust occurs, be reblasted to a near-white condition. The wire brushed or blast cleaned surfaces shall be vacuumed and reprimed.

For structures with piers, a minimum of 5 feet on each side of the piers shall be blast cleaned on the same day and primed as a unit to prevent damage to previously primed surfaces.

d. Mixing the Coating.-The coating shall be mixed with a high shear mixer (such as Jiffy Mixer) in accordance with the manufacturer's directions, to a smooth, lump-free consistency. Paddle mixers or paint shakers are not allowed. Mixing shall be done, as far as possible, in the original containers and shall be continued until all of the metallic powder or pigment is in suspension.

Care shall be taken to ensure that all of the coating solids that may have settled to the bottom of the container are thoroughly dispersed. The coating shall then be strained through a screen having openings no larger than those specified for a No. 50 sieve in ASTM E 11. After straining, the mixed primer shall be kept under continuous agitation up to and during the time of application.

e. Thinning the Coating.-In general the coatings are supplied for normal use without thinning. If it is necessary to thin the coating for proper application in cool weather or to obtain better coverage of the urethane topcoat, the thinning shall be done in accordance with the manufacturer's recommendations.

f. Conditions for Coating.-Coating shall be applied only when the following conditions have been met:

1. Temperature.-The temperature of the air and the steel shall be above 50 F for coatings other than the topcoat. For the urethane topcoat, the temperature of the air and steel shall be above 40 F. Coatings shall not be applied if the temperature is high enough to cause blistering.
2. Humidity.-The coating shall not be applied when the relative humidity is greater than 90 percent nor when a combination of temperature and humidity conditions are such that moisture condenses on the surface being coated.

g. Coating of Structures.-After the surface to be coated has been cleaned and approved by the Engineer, the coatings shall be applied with the spray nozzles and pressures recommended by the producer of the coating system, so as to attain the film thicknesses specified. The minimum dry film thickness for the primer shall be 3 mils, for the intermediate coat: 3.5 mils, and for the urethane topcoat: sufficient to provide complete coverage and a uniform color and appearance (See Note 2). The dry film thickness will be determined by use of a magnetic film thickness gage. The gage shall be calibrated on the blasted steel

with plastic shims approximately the same thickness as the minimum dry film thickness. A Tooke film thickness gage may be used to verify the coating thickness when requested by the Engineer (See Note 3). If the Tooke gage shows the primer coat to be less than the specified minimum thickness, the total coating system will be rejected even if the total dry film thickness exceeds the minimum.

If the application of coating at the required thickness in one pass produces runs, bubbles, or sags, the coating shall be applied in multiple passes of the spray gun, the passes separated by several minutes. Where excessive coating thickness produces "mud-cracking," such coating shall be scraped back to soundly bonded coating and the area recoated to the required thickness.

All dry spray shall be removed, by sanding if necessary. In areas of deficient primer thickness, the areas shall be thoroughly cleaned with power washing equipment, as necessary to remove all dirt; the areas shall then be wire brushed, vacuumed, and recoated.

Proper curing conditions will be required between the application of all coats. Minimum curing times for each product of the system are listed on the Qualified Products List. No more than 60 calendar days will be permitted between coats. If this limit is exceeded, all newly coated surfaces shall be hand sanded and wiped or blown clean prior to the next coat.

After the steel is primed, it shall be vacuumed again before subsequent coating. If for any reason this vacuuming does not remove all the accumulated dust and/or dirt, or if more than 3 weeks has elapsed since the steel was primed, or if in the opinion of the Engineer the surface is unfit for topcoating, the surface shall be scrubbed with a mild detergent solution (any commercial laundry detergent) and thoroughly rinsed with water and allowed to dry for 24 hours before the surface is coated.

All metal coated with impure, unsatisfactory, or unauthorized coating material, or coated in an unworkmanlike or objectionable manner, shall be thoroughly cleaned and recoated or otherwise corrected as directed by the Engineer.

h. Provisions for Field Inspection.-The Contractor shall furnish and erect scaffolding meeting the approval of the Engineer to permit inspection of the steel prior to and after coating.

Rubber rollers, or other protective devices meeting the approval of the Engineer, shall be used on scaffold fastenings. Metal rollers or clamps and other types fastenings which will mar or damage freshly coated surfaces shall not be used.

i. Protection of the Work.-Pedestrian, vehicular, and other traffic upon or underneath the structure shall be protected as provided under Subsection 1.05.13 of the 1984 Standard Specifications. All portions of the structures (superstructure, substructure, slope protection, and highway appurtenances) shall be protected against splatter, splashes, and smirches of coating or coating material by means of protective covering suitable for the purpose. Similar protection shall be afforded any highway appurtenances that could be damaged by blast cleaning operations. The Contractor shall be responsible for any damage caused by his operations to vehicles, persons, or property.

During blast cleaning operations, the Contractor shall make provisions for protecting existing traffic from any hazards resulting from the blast cleaning operations. These provisions shall include a type of barrier system which would protect against direct blasting of vehicles or pedestrians, eliminate abrasive materials and debris from falling on the traveled portions of the pavement, and

prevent the spreading of abrasive materials and debris into an area which would create a traffic hazard.

Whenever the intended purposes of the protective devices are not being accomplished, work shall be suspended until corrections are made. In addition, any abrasive material and debris deposited on the pavement, shoulders, or slope paving in the working area shall be removed before those areas are reopened to traffic.

j. Stenciling Requirement.-At the completion of the coating, the completion date (month and year) and the number of the type of coating system used shall be stenciled on the structure in 4-inch numbers; for example: 6/85-4. The paint used for this marking shall be the same as the topcoat except the color shall be black.

The numbers shall be stenciled on the inside of each facia beam at the approaching traffic end of the structure. The two required markings shall be located at least 10 feet above ground level or the fill slope elevation and at least 10 feet from the abutment. If these locations are not applicable to the structure, the locations of the two markings will be designated by the Engineer.

k. Measurement and Payment.-The completed work as measured for CLEANING AND COATING EXISTING STEEL STRUCTURES will be paid for at the contract unit prices for the following contract items (pay items).

Pay Item	Pay Unit
Cleaning Existing Steel Structure, Type 4 (Structure No.). .	Lump Sum
Coating Existing Steel Structure, Type 4 (Structure No.). .	Lump Sum

Stenciling is considered a part of the work of Coating Existing Steel Structure, Type 4 and will not be paid for separately.

Cleaning and coating existing utility conduits including all brackets and hangers, when called for on the plans, is considered a part of the work of Cleaning and Coating Existing Steel Structure, Type 4 and will not be paid for separately.

The following notes are listed only to be a help to the bidder in determining the bid. They are not contract provisions, but point out some of the not so obvious problems we have encountered during our blasting and coating of weathered A-588 Steel and heavily corroded structural steel.

Note 1. In many areas, especially under joints, the steel is heavily pitted. The complete removal of the last remaining trace of visible rust products is practically impossible. This being the case the definition of a near-white blast cannot be achieved. To solve this problem in these areas the appearance of a near-white blast is required, i.e. when compared to the visual standard the surface shall look the same. Even this is difficult but it does allow for very very small rust deposits at the base of a pit.

Note 2. Once again the pitting in the blasted surface causes a problem. The dry film thickness of the primer varies greatly, typically between 3 and 12 mils. The specification calls for a minimum of 3 mils; to achieve this much more paint than normal is required in a pitted area. The inspector is instructed to look for the low areas.

There are some spray techniques and equipment that greatly affect the amount of urethane that is required for complete coverage and a uniform appearance. These include the application technique of both the primer and the intermediate coat.

Note 3. All dry film thickness gages shall be calibrated on a relatively smooth section of the blasted web, not in a heavily pitted area.

Approved Low Dusting Abrasives

1. Starblast - DuPont - Wilmington, Delaware 09898
2. Copper Blast - Rocky Mountain Energy - Magna, Utah
3. Green Diamond, Grade 2050 or 3060 - Reed Minerals Division - Highland, Indiana 46322

MICHIGAN DEPARTMENT OF TRANSPORTATION

Qualified Product List
Systems Listed in Alphabetical Order by Producer
Use: Coating of Existing Steel Structures
Type 4

Producer	Represented By:	Coats	Products	Dry Film Thickness Mils Min.	Color	Min./Time Between Coats Hrs.
Ameron Protective Coatings Division 201 North Berry Street Brea, CA 92621	B. Marshall Same 313-886-5555	1st	Dimetcoat 68	3.0	-----	48
		2nd	Amercoat 383HS	3.5	White	24
		3rd	Amercoat 450GL	*	15200	
Carboline 320 Hanley Industrial Ct. St. Louis, MO 63144	PCA, Inc. 6315 E. 7 Mile, Suite 200 Detroit, MI 48234 313-891-2060	1st	Carboline 658	3.0	-----	48
		2nd	Carboline 190FD	3.5	White	24
		3rd	Carboline 134	*	15200	
Devoe-Wapko P.O. Box 7600 Louisville, KY 40207	Same 502-897-9861	1st	Zinc Prime 115	3.0	-----	48
		2nd	547 Cheafast Epoxy	3.5	White	24
		3rd	369 Prufthane	*	15200	
M.A. Bruder 630 North Third Street Terre Haute, IN 47808	Same 812-234-6621	1st	Ply-tile Zinc Rich Primer	3.0	-----	48
		2nd	Ply-tile Mastic 101	3.5	White	24
		3rd	Plythane 880	*	15200	
P.P.G. Industries 9933 Lawler Ave. Suite 260 Skokie, IL 60077	John Felice 3928 West Saginaw Lansing, MI 48917 517-323-9144	1st	Aquapon Zinc Rich	3.0	-----	48
		2nd	Aquapon 97-3	3.5	White	24
		3rd	Pitthane CP3665	*	15200	
Porter Paint Company 400 South 13 Street Louisville, KY 40201 502-588-9200	Pontiac Paint Company 1310 West Wide Track Dr. Pontiac, MI 48058	1st	Zinc Lock 308	3.0	-----	48
		2nd	MCR 43	3.5	White	24
		3rd	Hythane	*	15200	
Sherwin Williams	Sherwin Williams 2121 South Cedar Lansing, MI 48910 517-482-5587	1st	Zinc Clad 7	3.0	-----	48
		2nd	Tile Clad II	3.5	White	24
		3rd	Rexthane	*	15200	
Tnemec Company, Inc North Kansas City, Missouri 64116	Mich Protective Coatings Brad Brown P.O. Box 39287 Detroit, MI 48239 313-538-7878	1st	90-94 Tneme-Zinc	3.0	-----	48
		2nd	Series 66 Epoxoline	3.5	White	24
		3rd	Series 72 Endura Shield II	*	15200	
Valspar Corporation 901 N. Greenwood Ave. Kankakee, IL 60901	Same 815-933-5561	1st	MZ-4	3.0	-----	48
		2nd	Val-Chem 89 Epoxy	3.5	White	24
		3rd	40 Series Urethane	*	15200	

* The urethane topcoat shall be of sufficient dry film thickness to completely cover the intermediate coat and produce a uniform color and appearance.