NEPCOAT: APPROACH TO SPECIFYING AND TESTING LOW VOC BRIDGE COATINGS

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ABSTRACT

Background and overview of the regional NEPCOAT (Northeast Protective Coatings Committee) process to evaluate and qualify proprietary 3-coat paint systems through accelerated lab testing for use on shop-applied new steel and field-applied completely-cleaned existing bridges.

INTRODUCTION

In recent years State and Federal regulations concerning Volatile Organic Compounds (VOC) and lead content of bridge paints have resulted in a paradigm shift in the types of coatings being utilized by State Departments of Transportation and Bridge Authorities to protect bridges from corrosion. For over fifty years owners have relied on lead-bearing alkyd systems with good success. These coatings were generic recipe-type formulations produced by a large number of suppliers across the country.

With the arrival of stringent new regulations governing the use and removal of lead-bearing coatings these reliable systems were no longer cost effective to use. Owners turned to other systems with compliant materials. The system of choice for use in harsh environments was typically a zinc primer / epoxy / urethane system.

The continuing emergence of new paint products in response to changing regulations posed a problem for owners - how to specify and evaluate products with proprietary composition and limited field history while still permitting development and ensuring competition. Many owners started the process by painting a small structure or test area with new systems and evaluating them over time.

This method of evaluation had three drawbacks. First, it took considerable time to obtain results, usually several years, and significant effort for the owner in managing performance evaluations.

The second concern was the identification or “finger printing” of a system. After years of evaluation how could the owner be sure that the paint arriving at the jobsite had the same formulation as that tested? This is a major concern to owners and material continuity and verification was sometimes lacking in the evaluation process.

The third concern was the reduction of allowable VOC levels in coatings by the EPA (Environmental Protection Agency). By the time some systems completed evaluation after years of testing they needed to be reformulated to meet actual or anticipated lower VOC allowable levels.

BACKGROUND

This approval predicament facing owners was the reason for starting NEPCOAT. NEPCOAT is a consortium, first of New England states and now northeast states, formed to collaborate on resolving bridge coating issues. NEPCOAT members are Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont, along with New Jersey and Pennsylvania.

NEPCOAT starting in 1992 when Maine, New Hampshire and Vermont agreed to work together to develop a process for evaluating proprietary high performance coatings with the ultimate goal of generating a mutually endorsed prequalified list of approved systems. Martha Hsu of Maine, Richard Haupt of Vermont, and Alan Rawson of New Hampshire met with Peter Barlow of Connecticut in April 1992 to review Connecticut's process for evaluating coatings. Connecticut joined the effort at that time, followed by Massachusetts, Rhode Island, and in 1995 by New Jersey and Pennsylvania.

From 1992 to 1994 NEPCOAT met and conferred with coating experts from across the country as the coating evaluation process was developed. Input was received from coating manufacturers, testing laboratories, consultants, test equipment manufacturers, FHWA, and other states. The finished NEPCOAT specification was approved June 15, 1994 and testing began shortly thereafter.

OVERVIEW OF KEY ISSUES IN DEVELOPING THE EVALUATION PROCESS

1. Who would do the testing and pay for it?

NEPCOAT realized that it would be difficult for an owner to meet the testing and funding demands of this coating evaluation program. NEPCOAT decided the solution was to test using approved private testing laboratories with funding provided by coating manufacturers.

2. What types of coating systems would be considered for evaluation?

After considerable discussion NEPCOAT decided to go with what was at that time perceived to be the best performing coating system, namely, zinc primer, epoxy or urethane intermediate, and aliphatic urethane top coat. Although this system was expensive the cost was justified because of good performance in harsh New England exposures and because of the major costs associated with going back to renew failed coatings after project completion.

Part of this issue was deciding on the number of coats. NEPCOAT recognized that some one- and two-coat systems performed well, but felt the best system for overall performance was a three-coat system. Nevertheless, testing was established for each coat in the system (i.e. primer, primer plus intermediate, and the complete system) and the results would provide a basis for an owner to choose one- or two-coat systems, if needed.

Primers would be either inorganic zinc meeting AASHTO M 300, Inorganic Zinc Rich Primers, or organic zinc meeting SSPC, Paint 20, Type II. However, NEPCOAT decided that other viable zinc primers on the market not meeting these requirements would be allowed provided they met the testing requirements.

3. What painting category would be covered by the NEPCOAT specification - shop-applied new steel or maintenance overcoating?

From the start NEPCOAT established shop-applied new steel as the priority category. The scope was broadened to include field application of totally cleaned existing steel. The NEPCOAT testing and evaluation to date has been performed for these two categories only.

Qualifying coatings for the category of maintenance overcoating of existing painted structures is a pressing and important need for owners. NEPCOAT deferred this issue to a later date in order to complete the first priority and because of the difficulties involved. Accelerated lab testing would probably not be effective for evaluation since it would be difficult to achieve uniformly aged panels to provide a equal basis for testing. In addition, a large number of systems would be involved since every state used different coating systems.

For shop-applied new steel a surface preparation of SSPC-SP10 is required with a surface profile of 1.5-2.5 mils (40-65 microns). For field-applied systems on totally cleaned existing structures the required surface preparation is SSPC-SP6, SP10 or SP11 with a profile range of 1.5-4.5 mils (40-115 microns).

4. How would NEPCOAT ensure environmentally safe coatings?

NEPCOAT required that all coatings comply with environmental regulations. The issue for new coatings was lead in the zinc dust, therefore, a compliant level was specified for ASTM D520 Dust (Metallic Zinc Powder), Type II and manufacturers were required to submit test data from zinc suppliers showing conformance with the requirements. In addition, it was required that each coating (primer, intermediate and top coat) be tested for total lead in accordance with ASTM D 3335, with the level not to exceed 0.01% (100 ppm).

To further ensure compliance for the complete system a statement was added that all coatings be formulated in compliance with regulations governing toxic heavy metals.

5. Should NEPCOAT specify VOC's?

In 1992 the maximum federal VOC level for miscellaneous shop facilities in ozone non-attainment areas was 3.5 lb./gal (420 g/l) but was anticipated to drop to 2.8 lb./gal (336 g/l). NEPCOAT set the maximum VOC level at 3.5 lb./gal but recommended that manufacturers use the lower level as a precautionary measure. NEPCOAT defined the VOC level at the time of application after thinning. The 1997 version of NEPCOAT contains the VOC classification levels endorsed by SSPC.

6. How could a coating system be "finger printed" to verify production lots?

This assurance is essential to owners so they know they are receiving the same coating at the jobsite that passed NEPCOAT testing. To assist in verification testing, manufacturers are required to submit data documenting standard coating properties, such as percent total solids by weight, percent pigment by weight, percent metallic zinc in primer, percent total solids by volume, weight per gallon, viscosity, pot life and sag resistance. For further identification an infrared scan on each coat is required by the testing laboratory. The 1997 NEPCOAT version includes further "finger printing" requirements, including x-ray diffraction of extracted primer pigment, and a submittal by the manufacturer certifying the chemical nature of the coating system including, but not limited to NCO equivalent weights, epoxide values, and amine values.

7. What tests would be appropriate in the coating evaluation process?

Test 1 Class B Slip Coefficient- This test was included for shop-applied new steel since the standard practice of many owners was to paint bolted connections designed for Class B. However, owners could waive this when bolted surfaces are not painted or for pre-bolted existing structures. The 1994 NEPCOAT version required a surface preparation on test panels using 95 percent steel shot with 5 percent steel grit mixture because this was the standard practice. The 1997 version of NEPCOAT requires that all systems be tested and report the results using 100 percent steel shot, considered to be the worst case.

Test 2 Salt Fog - This test is widely used for accelerated testing of bridge coatings in spite of the fact that it does not correlate directly to actual field performance. NEPCOAT included the salt fog test because of its traditional role and broad industry recognition, and because of the severe salt exposures that bridges experience in the northeast with both marine and de-icing salts.

Test 3 Weathering- The weathering test was deemed necessary to evaluate how coatings would stand up to the aging effects of ultraviolet light. The issue became one of specifying UV condensation versus Xenon Arc. Experts from both sides of the issue presented their perspective to NEPCOAT. It was felt that the Xenon Arc probably most closely simulated natural light, but its use would almost double the overall cost of testing. NEPCOAT decided to go with UV condensation.

The 1997 version of NEPCOAT has eliminated the UV condensation test in favor of a cyclic combination prohesion/UV condensation test meeting the requirements of ASTM D5894, Cyclic Weathering Resistance Test. This change is being made because this test likely has a higher correlation with field performance according to FHWA.

Weathering testing includes an evaluation of color change, gloss values and percent of gloss retention. These values are reported only and are provided to users for aesthetic considerations.

Test 4 Relative Humidity Resistance- This test was included in the evaluation process in an attempt to simulate the effects of the humid natural environment existing in the northeast, as well as bridge water crossings. Testing to date has shown that the high performance coating systems have been affected very little by the demands of this test.

Test 5 Abrasion Resistance- The results of this test are reported only, but NEPCOAT felt that this information would be important to owners who may select coatings for bridge structures with a high potential for abrasion, as from winter sand thrown against a truss or through-plate girder.

Test 6 Adhesion- NEPCOAT felt this was an important test. Many coating failures are caused by poor adhesion, faulting either the coating or surface preparation. The minimum values established for inorganic zinc primers and organic zinc primers were 250 and 600 psi (1.7 and 4.1 MPa), respectively. These values were established from field testing completed by Peter Barlow of Connecticut DOT. This test is performed on test panels with the complete three-coat system.

Test 7 Freeze Thaw Stability- This test is being added to the 1997 NEPCOAT version at the suggestion of Tom Neal, a consultant recently retired from Virginia DOT. NEPCOAT agreed that this was appropriate considering the many freeze-thaw cycles bridges are exposed to in northern climates. This test has a duration of 30 days with a daily cycle consisting of freeze, thaw, followed by immersion in tap water. At the end of freeze-thaw testing, adhesion testing is performed. No reduction in adhesion values is allowed when comparing results with Test 6.

Field History- NEPCOAT recognized field history to be a significant problem since many new paint formulations had limited or no field history. NEPCOAT permitted conditional acceptance that once a system had successfully passed the laboratory performance testing it had three years to document two years of successful field history. Field history has to show successful use of the system on ten projects each utilizing a minimum of 105 gal. (400 liters) in a cold wet climate. The overall NEPCOAT approval is for a time period of four years.

FREQUENTLY ASKED QUESTIONS

1. Why did the NEPCOAT acceptance criteria change in 1996 from the 1994 original?

When NEPCOAT developed the evaluation process initially, it did not know how well coatings would stand up to the rigors of testing. The idea was to set high standards in order to obtain the best coatings available, while staying within a range which made sense in terms of real world exposure. The initial acceptance limits were set after consultation with experts in the industry, recognizing that there would be adjustments after the first round of testing was completed. These acceptance adjustments were made on June 5, 1996.

2. How is NEPCOAT tied into AASHTO and NTPEP?

NTPEP (National Transportation Product Evaluation Program) is a program operated under the auspices of AASHTO (American Association of State Highway and

Transportation Officials) to evaluate transportation products for member states.

Word of the NEPCOAT effort spread and the states in Federal Highway Region 3 adopted it. Thereafter, Tom Neal rewrote the NEPCOAT specification into an AASHTO test procedure format. The rewritten AASHTO version was given to the AASHTO Technical Section 4c, Subcommittee on Materials, chaired by Leo Stevens of Massachusetts, for possible adoption.

The AASHTO version received input from states across the country and was further refined by Eldon Orth of Nebraska and Jerry Zoller of New Hampshire. The document was balloted by AASHTO for a second time in September 1996 for national acceptance as a provisional guide specification.

Meanwhile, NEPCOAT adopted the improvements from the AASHTO guide version, essentially merging the two documents, except that NEPCOAT has replaced test 3 with the cyclic weathering prohesion/UV CONDENSATION tests as described above. AASHTO may consider this addition as well.

NTPEP will play a major role in this evaluation process as the testing program moves to a national level. NTPEP will oversee consolidated testing, beneficial both for manufacturers and owners alike with significant cost savings anticipated for both. Under NTPEP management, states receive test results but without acceptance recommendations. States must set acceptance criteria for their use.

NTPEP has responded to requests from states and is now drafting a final version of the structural steel coating evaluation process, which will be used to contract with a selected qualified laboratory. Richard Hanlon, of West Virginia DOT, is Chairman of the "NTPEP Structural Steel Coating Project Panel."

Under NTPEP management, coating manufacturers would pay a fee to NTPEP to have their system evaluated. NTPEP would then contract private qualified laboratories to provide these testing services.

3. What will happen to NEPCOAT as testing goes national under NTPEP?

NTPEP will oversee the testing program on a national level, but since it will only provide test results and not set acceptance criteria, NEPCOAT and individual states need to determine acceptance standards and issue a qualified list of acceptable coatings. Setting coating acceptance levels for the northeast region will continue to be one of NEPCOAT's functions.

In addition, NEPCOAT will continue to work together, share information and address other coating issues. The next agenda item is developing a field-applied patch test protocol for use in qualifying coatings for overcoating applications.

4. Will other types of systems be evaluated?

There have been many requests to evaluate other types of coatings and significant discussions by NEPCOAT, AASHTO and NTPEP on this topic. It would seem likely that it is only a matter of time before such testing comes about.

SUMMARY

At a time of tremendous change in bridge coatings the NEPCOAT evaluation process offers a relatively quick means for evaluating and "finger printing" proprietary coating systems for application to bare bridge steel.

The NEPCOAT process has three major benefits. First, it allows manufacturers to change coating formulations to adapt to changes in environmental regulations, addressing both toxicity issues and VOC compliance. Second, the time to gain broad base acceptance is shortened. This is significant to manufacturers who are able to gain recognition and acceptance in a large market of owners for a relatively small cost and reduced promotional effort. Third, for the owner, the test data provides a basis to establish a qualified products list without unnecessary repetition, and provide a basis for verifying production lots at the jobsite.

The original NEPCOAT specification was approved June 15, 1994 and ten systems have been conditionally qualified as of January 1997 pending documentation of successful field history. NEPCOAT is currently working on an updated 1997 version to take effect June 1, 1997.