MnDOT Powder Coating Qualification Testing Procedure

The test procedures contained herein describe the process for submittal, testing, and evaluation of powder materials for use in MnDOT powder coating applications. Applied powder materials which meet or exceed the stated performance criteria will be eligible to be listed on the MnDOT Approved Products List (APL). Provide lab test results establishing that the powder coating applicator’s system for a particular Powder Product applied over Hot-dipped galvanized or abrasive blasted steel, works as a system, as defined below:

1. Send a submittal package to:

   Allen Gallistel  
   Chemical Laboratory Director  
   MnDOT Office of Materials  
   1400 Gervais Ave.  
   Maplewood, MN 55109  
   651-366-5545  
   allen.gallistel@state.mn.us

2. Include the following in the submittal package:

   • Completed New Products Application Form (attached);
   • Powder Coating Applicator contact name, address, phone number and email address;
   • Letter identifying each individual powder coat trade name;
   • Powder manufacturer’s recommended DFT for each powder used in the tested system;
   • Hard copy lab tests proving compliance that the Powder Coating material(s) meet the industry specification AAMA 2604 requirements;
   • Product Data Sheets on all components;
   • Safety Data Sheets (SDS);
   • Certification from the powder manufacturer that products meet Minnesota Statute 115A.9651 requirements for heavy metals;
   • One pound of each component for Infrared Spectrum matching Federal Standard RAL K5 Classic No. 7031 (blue gray), in semi-matt finish. Any un-approved change to system formulation will result in removal from the Approved Products List. Infrared Scans will be used as references for Quality Assurance Testing for future awarded jobs;
   • If galvanized, DFT documentation from the Galvanizer which demonstrate compliance to this document;
   • Completed test data per table in section 3e.
   • Provide written documentation per ASTM D2244 stating the color meets the standard by a $\Delta E \leq 2$, and
   • Completed MnDOT Office of Environmental Services Hazardous Evaluation Process Documentation (attached).
3. Performance Testing

Performance testing shall be performed by a laboratory that is acceptable to the Engineer. All associated testing will be at the expense of the submitter.

   a) Steel Panels: Supply the following:
      • All systems: five – 6 in. x 6 in. x ¼ in. steel (MnDOT 3306 steel) test panels [one control, two salt fog, two adhesion];
      • For all systems: two – 2\(\frac{7}{8}\) in. x 6 in. x ¼ in. steel (MnDOT 3306 steel) test panels for UV-Con testing.
      • Permanently identify each panel by means acceptable to the MnDOT.

   b) For Duplex systems, Hot-dip Galvanize steel panels per MnDOT 3394 and 2402 Special Provision for Ornamental Metal Railing – Powder Coating,
      • Perform SSPC-SP6 blast cleaning prior to galvanizing;
      • Use a MnDOT Approved Galvanizer on file at [http://www.dot.state.mn.us/bridge/pdf/approvedsuppliers.pdf](http://www.dot.state.mn.us/bridge/pdf/approvedsuppliers.pdf)

   c) Powder Coating Material:
      • For testing purposes make the color of the final topcoat conform to Federal Standard RAL K5 Classic No. 7031 (blue gray), in semi-matt finish.
      • Provide written documentation per ASTM D2244 stating the color meets the standard by a \(\Delta E \leq 2\) prior to testing the plates and \(\Delta E \leq 5\) after UV-Con testing is completed.

   d) Application of Powder:

This portion of the qualification process has the Powder Coating Applicator document specific criteria that powder coated components must conform to in order to meet the quality and intent of the finished product. Contact MnDOT Bridge Office Structural Metals Unit prior to starting abrasive blasting of the test panels.

   • Perform the SSPC-SP10 (powder only systems)/SSPC-SP16 (duplex systems) abrasive blast cleaning as applicable, and the powder coating application in the presence of a Structural Metals Unit Inspector at the Powder Coating Facility.
   • For each panel, document an average of 3 blast profile readings.
   • Apply powder coat system according to manufacturer’s recommendation.

Provide the minimum requirements and frequencies in the Quality Control Procedure as shown in this table.

<table>
<thead>
<tr>
<th>Powder Coating Inspection Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Requirement</strong></td>
</tr>
<tr>
<td>Date and time</td>
</tr>
<tr>
<td>Compressed air test</td>
</tr>
<tr>
<td>Final Dry Film Thickness (DFT)</td>
</tr>
</tbody>
</table>

Surface Preparation
<table>
<thead>
<tr>
<th>Abrasive blast clean</th>
<th>SSPC-SP 6</th>
<th>Each component to be powder coated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duplex System (prior to galv.)</td>
<td>SSPC-SP 16/ASTM D7803</td>
<td>Each component to be powder coated</td>
</tr>
<tr>
<td>Duplex System (prior to powder)</td>
<td>SSPC-SP 10</td>
<td>Each component to be powder coated</td>
</tr>
<tr>
<td>Powder Only System (prior to powder)</td>
<td>SSPC-PA 1</td>
<td>100% Visual examination prior to coating</td>
</tr>
<tr>
<td>Surface cleanliness (all systems)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Pre-Bake for Outgassing (Duplex System)

<table>
<thead>
<tr>
<th>Surface cleanliness</th>
<th>SSPC-PA 1</th>
<th>100% Visual examination prior to coating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-bake material temperature</td>
<td>Adequate to prevent defects due to outgassing during powder application</td>
<td>Each lot of work</td>
</tr>
<tr>
<td>Baking procedure</td>
<td>ASTM D7803</td>
<td>Each lot of work</td>
</tr>
</tbody>
</table>

### Prime / Intermediate Coat

<table>
<thead>
<tr>
<th>Powder product number</th>
<th>Track for each lot</th>
<th>Each batch of powder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface cleanliness inspection</td>
<td>SSPC-PA 1</td>
<td>Visual examination prior to powder (within 1 hr of coating)</td>
</tr>
<tr>
<td>Oven temperature</td>
<td>Manufacturer recommendation</td>
<td>Each lot of work</td>
</tr>
<tr>
<td>Temperature of component at time of coating</td>
<td>Manufacturer recommendation</td>
<td>Each lot of work</td>
</tr>
<tr>
<td>Verification of prime / intermediate coat coverage</td>
<td>100% Coverage of powder</td>
<td>100% Visual Inspection</td>
</tr>
</tbody>
</table>

### Top Coat

<table>
<thead>
<tr>
<th>Powder product number</th>
<th>Track for each lot</th>
<th>Each batch of powder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface cleanliness inspection</td>
<td>SSPC-PA 1</td>
<td>Visual examination prior to coating</td>
</tr>
<tr>
<td>Top coat oven temperature</td>
<td>Manufacturer recommendation</td>
<td>Each lot of work</td>
</tr>
<tr>
<td>Final cure temperature of component</td>
<td>Manufacturer recommendation</td>
<td>Each lot of work</td>
</tr>
<tr>
<td>Curing time</td>
<td>Manufacturer recommendation</td>
<td>Each lot of work</td>
</tr>
<tr>
<td>Coating evaluation / repair</td>
<td>Visual Inspection</td>
<td>100% Visual Inspection (without the aid of magnification)</td>
</tr>
</tbody>
</table>

Coating shall be smooth and uniform free of runs, drips, sags, pinholes, blisters, and other deleterious conditions. (Pinhole density shall not be greater than 5 pin holes per sq. ft. in any given area)

### e) Performance Testing of Coated Test Panels:

<table>
<thead>
<tr>
<th>MnDOT Powder Coating Performance Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Criteria</td>
</tr>
<tr>
<td>----------</td>
</tr>
<tr>
<td>New Panels (initial testing)</td>
</tr>
<tr>
<td>Total Film Thickness</td>
</tr>
<tr>
<td>Visual Inspection</td>
</tr>
<tr>
<td>Pinholes</td>
</tr>
</tbody>
</table>

---
### Pencil Hardness

<table>
<thead>
<tr>
<th></th>
<th>ASTM 3363</th>
<th>H-2H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adhesion</td>
<td>ASTM D 4541- Apparatus Listed in Annex 1-5</td>
<td>Report adhesion values</td>
</tr>
</tbody>
</table>

### Color / Gloss

<table>
<thead>
<tr>
<th></th>
<th>ASTM D 2244</th>
<th>ASTM D 523 – Specular Gloss</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Color match to standard of $\Delta E &lt; 2.0$</td>
<td>Gloss – report</td>
</tr>
</tbody>
</table>

### Aged Panels (post testing)

<table>
<thead>
<tr>
<th></th>
<th>ASTM D4587 Cycle 4 (1500 hours)</th>
<th>- Photos - Report change in color from standard ($\Delta E$, 5.0 max) - Gloss – report</th>
</tr>
</thead>
</table>

| Salt Spray (All systems) | ASTM B117 (2000 hours) Blister Resistance ASTM D 714 | - Photos - Rust Creep ASTM D 1654 Procedure A Method 1, $\geq 7$ - Blister size rating $\geq 7$ with a frequency rating of Few |

### Commentary:

The phenomenon of pin holing in powders applied over hot dip galvanized surfaces has been identified as a serious problem associated with coating integrity and aesthetics. The presence of pinholes gives chlorides and other corrosives access to the zinc substrate with consequent production of bulky zinc corrosion products which leach out through powder coatings.

Pinholes of concern are identified as small around 1 mm in diameter swelled blister like areas that when bursting form a small hole through the entire thickness of the coating down to the hot-dipped galvanized layer. The formation of these pimply defects in the cured film is unacceptable and should be minimized or eliminated.

Powder manufacturers, along with powder coaters, have combined to develop systems and technology that minimizes or eliminates pin holing.

Control pin holing by:

- Pre-heating the work prior to applying powder,
- Use of ‘degassing’ grades of powder that cure slower increasing flash off time,

Cleaning surfaces prior to powder coating to eliminate hydrophobic organic contaminants that would attract moisture.

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f) **Notification:**

MnDOT will notify the Powder Coating Submitter of the approval status upon review of submittal package.

Upon meeting acceptance criteria, the submitted powder products will be placed on MnDOT’s Approved Products List [www.dot.state.mn.us/products](http://www.dot.state.mn.us/products).

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New Product ID # ____________
(For MnDOT Use Only)  

State of Minnesota
Department of Transportation
New Product Preliminary Information Form

INSTRUCTIONS: Answer ALL questions. Where a question is not applicable enter "N/A". Attach additional sheet(s) as required with reference to item number.

Date: ______________________

1. Trade Name ________________________________________________

Manufacturer ______________________
Phone No. (___) ____________

Address____________________City________State__Zip __ Patent pending
Yes______________No_____ Patent No. __________

2. Local Distributor_________________________ Phone No. (___) ____________

Address____________________City________State_____Zip ______

3. Recommended Use:__________________________________________ Primary

4. Describe product, material equipment or process:

________________________________________________________________________

5. Describe any limitations or use restrictions:

________________________________________________________________________
6. Material composition (attach laboratory test results, storage requirement, shelf life, Material Safety Data Sheet and disposal procedure):

____________________________________________________________________

____________________________________________________________________

7. Outstanding feature or advantage claimed:

____________________________________________________________________

____________________________________________________________________

8. Date introduced on market_______________. Alternate for what existing product?

____________________________________________________________________

9. a. Total Estimated Cost Per Unit Material (including delivery) ________________
   b. Total Estimated Cost Per Unit Furnished and Installed ____________________

10. Does product meet requirements of any of the following specifications? (Give specific number.)
    AASHTO ________ ASTM _________ Fed. Spec. _________ MnDOT __________
    Others (state and attach specifications) ____________________________________

11. Indicate whether this product has been evaluated by a national or regional product evaluation program? (Attach any results.)
    HITEC ________ NTPEP ________ Others (specify) _______________________

12. Cite use by other agencies and persons to be contacted concerning experience with use, including how many years used, and whether use has been experimental or routine (list names, titles, mailing address and phones):

____________________________________________________________________
13. Note here and attach any test results, reports, etc., from the organizations above:


14. Is a documented quality control process available for this product? 


15. Who has been contacted within MnDOT about this product? 


Has this person been sent a copy of this form? 


16. Additional comments:


Name and Title of person completing this form:


Address, State, Zip:


Date: Phone: ( ) 


Email Address: 


Manufacturer Representative
MnDOT Office of Environmental Services
Hazardous Evaluation Process

The MnDOT Office of Environmental Services developed the Hazard Evaluation Process (HEP) as a tool to determine potential environmental impacts that could result from use of a product and consequently, if the product is acceptable for use on MnDOT infrastructure. The following information must be submitted by the vendor in order for MnDOT to complete the HEP:

1. Vendor information
   a. Name of Company
   b. Address
   c. Technical Contact Name and Telephone Number
   d. Application Date
   e. Product Trade Name
   f. Product Chemical Name
   g. Product Data Sheet

2. Provide Material Safety Data Sheets for all chemicals in the product/waste material.

3. Regulatory Approvals & Status:
   a. Licenses
   b. Approval
   c. Permits
   d. TSCA Listing

4. Chemical Status:
   a. Provide Individual Chemical & Physical Properties (OECD¹ Methods 102, 103, 104, 105, 111, 112, 113, 117, 121);
   b. Identify chemicals with molecular weights greater than 1000 Daltons (OECD Methods 118, 120 or equivalent);
   c. Certification that final product would not be considered a hazardous waste under Minnesota Rules Chapter 7045 if disposed of unused;
   d. Names and Chemical Abstract Numbers (CAS numbers) of the reportable substances in the product (40 CFR 302);

The following product-specific information must be submitted if known. If information for a representative test is unknown it must be stated as such. EPA SW-846 test method information can be found at: http://www.epa.gov/epaoswer/hazwaste/test/main.htm. OECD product test method information can be found at: http://www.oecd.org/home/ or http://www.oecd.org/document/23/0,2340,en_2649_34379_1948503_1_1_1_1,00.html. U.S. EPA Office of Prevention, Pesticides and Toxic Substances Harmonized Test Guidelines can be found at: http://www.epa.gov/opptsfrs/home/guidelin.htm.

   a. Leach test results (EPA Method 1311 and OECD Method 312 with subsequent analysis for test substance or equivalent method);
   b. Biodegradation (OECD Method 301C, 301D, 302C, 304A, 307, 309 or equivalent method);
   c. Ecotoxicity to include three trophic levels (OECD Method 201, 207, 208, 210, 211 or equivalent method, OPPTS Method 850.5400, 850.1300, 850.6200, 850.4100, 850.4150, 850.1400 or equivalent method);
   d. Other available test data that provide individual chemical fate, exposure and pathway information.
Organization for Economic Co-operation and Development methodology for product testing is preferred but equivalent methods may be acceptable.

Questions regarding the MnDOT Hazard Evaluation Process can be sent to:

Robert.Edstrom@state.mn.us