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INTRODUCTION

The purpose of this procedure manual is to define field and laboratory procedures for evaluating pavement-marking materials with the exception of raised and recessed pavement markers. This document will act as a best practices guide for the evaluation of pavement marking materials on American Association of State and Highway Officials (AASHTO) pavement marking test decks. Pavement-marking tests shall be performed under the auspices of the National Transportation Product Evaluation Program (NTPEP), which serves the member departments of AASHTO and Pavement Markings Manufacturers.

OVERVIEW

The Field Testing Procedures for fluid traffic markings performed on a NTPEP pavement test deck are based on ASTM D 713, "Standard Practice for Conducting Road Service Tests on Fluid Traffic Marking Materials." The use of LTL 2000 or LTL-X Retroreflectometers will be used to measure the retroreflectance of the samples. Additionally, appearance/color shall be determined through a combination of a color-measuring instrument; this instrument provides coordinates in CIE color units that can be converted for use in field and laboratory applications as well as a durability performance evaluation. Four transverse strips of each durable product shall be placed on each deck. Evaluations for removeability (ease of removal and number of pieces) and discernability (marking left on the surface after removal) have been uniquely developed for removable tapes. Six transverse strips and six longitudinal strips of each removable tape shall be placed on both the concrete and the asphalt deck.

Photo 1 shows an example of the longitudinal strips of removable tape. Photo 2 shows an example of the transverse strips of removable tape.

Photo 1. Removable Longitudinal Tapes

Photo 2. Removable Transverse Tapes

Evaluations will be conducted approximately every thirty (30) days for the first year and approximately every one hundred twenty (120) days for subsequent years on long-life materials. Daytime/Nighttime color, retroreflectivity, durability, and wet night retroreflectivity (upon vendor request) will be monitored, outliers identified, and an average rating calculated for each product evaluated. Additionally, a photo-log will be collected and maintained. A separate evaluation has been developed for removable tapes and will include retroreflectivity, daytime color/appearance, removability, and discernability.

Field evaluation results shall be uploaded to the NTPEP test deck database. The following information will be provided:

1. Site location, including ADT, percent heavy vehicles, type, age and special treatment of test surface material
2. Company information including name, code, class of material, binder, color, primer or other adhesives (if needed for durable markings), and indication if material contains lead
3. Application information including application equipment description, thickness, and temperature of material, relative humidity, auto-no-track time, and type and rate of application of bead if different from that specified.
4. Retroreflectability
5. Durability
6. Nighttime/Daytime color
7. Wet night retroreflectivity (upon vendor request)
8. Photo-log
9. Information on snowplow type/use and damage, amount of salt, amount of anti-skid, and salt/anti-skid by the ton, used on the test deck. Also, include specific winter wear conditions such as studded or chained tires.
10. Daily and Monthly average ambient temperature
11. Daily and Monthly average precipitation

The Laboratory Evaluation will consist of a number of ASTM and AASHTO tests depending on the material. These standard tests are now being conducted at the state level on the products they obtain. There is a lot of concern for the “Finger Printing” of the material tested. Because of this concern, a number of laboratory tests have been included for each material with the feeling that these would be rerun on samples of material purchased by states. The states could then compare these results with original tests to insure that the material tested is the same material purchased. An infrared scan can be done on some of the material, and this procedure is included where applicable.

Field and laboratory evaluation results will be provided upon request by a participating state for any or all products tested. Each participating state may submit any sample of material to the test facility for verification that the sample is the same product originally tested. Samples submitted by a state for verification without charge will be limited to five (5) per year.

SUBMITTAL GUIDELINES AND OTHER CONSIDERATIONS

Product Evaluation Forms (PEF) and supplementary forms should be submitted to the NTPEP Coordinator upon product application approval. A Traffic Paint Composition Form (TPCF) must be completed and attached to any PEF submitted for the testing of solvent-based, water-based and polyester-based paint. The information contained on the TPCF will be made available only to AASHTO member departments requesting such information. Manufacturers will be notified that their TPCF was released and which agency requested the information. (The TPCF is used as a means of project-level quality assurance, that the product tested by NTPEP is the same as that provided for a construction project.)

A Traffic Paint Composition Form (TPCF) must be completed and attached to any PEF submitted for the NTPEP laboratory retest policy to apply to the submitted product.

The Submittal package shall include Material Safety Data Sheets (MSDS), product technical bulletins, specifications, and literature relating to the special handling and/or proper disposal of submitted products. Products will not be accepted for evaluation without submittal of all of the above-mentioned documents.

The NTPEP Coordinator shall assign an "NTPEP ID" number to each product submitted to the program. The NTPEP ID number will be provided in written correspondence by the Coordinator.

The laboratory test samples taken at the field test deck sites will be shipped to the laboratory testing state within two (2) weeks following the installation of the materials at the field test sites.

The NTPEP Coordinator shall print and distribute the first year Interim Report within thirty (30) days of receiving the final copy (however, not later than October 1). The two-year (2) Interim Report, for long life materials, will be printed and distributed within thirty (30) days of receiving the final report (however, not later than October 1), from the lead field-testing state. A three-year (3) report for long-life durable marking will be printed and distributed within thirty

(30) days of receiving the final report from the lead field testing state. Participating Industry is given ten (10) business days to review the draft copies for each of these reports.

SECTION ONE: CONTRACT AND COSTS

1. Contract

This section contains information on formulation of the Test Deck Contract and calculation of associated costs. Additionally, it includes deliverables, required equipment, personnel, work zone costs, and estimated time requirements for deck installation. Coordination with stakeholders will be addressed in this section. This section includes a complete list of testing equipment, safety equipment, and vehicles needed. Locations for procurement and estimated costs will be included.

1.1 Deliverables

Project deliverables involve three phases, each with multiple tasks: 1) Project organizations and material installation. 2) Product monthly field evaluations 3) Product quarterly field evaluations.

1.1.1 Phase I

The first phase of the project includes organization and scheduling of the pavement markings installation, and will conclude with installation of the marking materials and initial product evaluation. During this phase of the project, the following activities shall be undertaken:

1) Select the required project staff including field management, contracted assistance, work zone control, and technical assistance.
2) Arrange for personnel training.
3) Secure field evaluation equipment.
4) Finalize test deck locations.
5) Secure lists of product suppliers and estimates of products applied by each manufacturer.
6) Organize and schedule the field application activities.
7) Maintain the operations on the test decks and supervise the application of all pavement-marking products.
8) Initial evaluations will be taken within seven (7) days of application of all samples. Each product will be evaluated for retroreflectivity, durability, daytime color, wet-night retroreflectivity (manufactures option), and photo logging.

1.1.2 Phase II

The second phase of the project includes the monthly field evaluations of the applied pavement markings on the two test decks. At approximately 30-day intervals, each durable product will be evaluated for retroreflectivity, durability, daytime color (quarterly), wet-night retroreflectivity, and photo logging. Additionally, each removable product will be evaluated for retroreflectivity, daytime color, removability, and discernible markings after removal. During this phase of the project, the following activities will be undertaken:

1) Organize and schedule the field evaluation activities.
2) Schedule traffic control.
3) Perform monthly field evaluations.
4) Upload monthly evaluations to AASHTO's NTPEP pavement test deck database.
5) Attend NTPEP annual meeting to present test deck information.
6) Prepare the first-year report for the AASHTO NTPEP committee.

1.1.3 PHASE III

The third and final phase of the project involves quarterly field evaluations of the applied pavement markings. At approximately 120-day intervals, each durable product will be evaluated for retroreflectivity, durability, daytime color, wet-night retroreflectivity, and photo logging. During this phase of the project, the following activities will be undertaken:

1) Organize and schedule the field evaluation activities for the decks for the duration of the project.
2) Schedule the traffic control.
3) Perform quarterly field evaluations.
4) Upload monthly evaluations to AASHTO's NTPEP pavement test deck database.
5) Attend NTPEP annual meetings to present test deck information
6) Prepare yearly reports for the AASHTO NTPEP committee at the end of each twelve-month period.

1.2 Required Equipment

Table 1 lists the required testing equipment for all Phases of the project. Included in the table are units of each product required, the recommended model, the supplier of the model, and contact information. Equipment listed is not meant as a promotion any one product but rather represents equipment historically used on NTPEP PM Test decks. Other equipment may be used with approval of the pavement marking committee.

Table 1. Required Equipment

Equipment	Unit	Recommended	Supplier	Contact	Phone
Testing Equipment					
Retroreflectometer	1 ea 1 ea	LTL X LTL 2000Y	Flint Trading	www.flinttrading.com	(336) 475-6600
Spectrophotometer	1 ea	Color-Guide(Gardner)	Flint Trading	www.flinttrading.com	(336) 475-6600
Film Thickness Gauge	3 ea	Dry Film Thickness Gauge (0-200 mils / 0-5 mm) integral - ferrous	S.G.P. Instrument Sales	www.sgpinstrumentsales.com	800-955-0574
Surface Temperature Gauge	3 ea	Raytek ST Pro Series Infrared Thermometer with Laser Guide	Raytek	http://www.raytek.com/	(800) 227-8074
Weather Station	1 ea	Davis, Complete Weather Monitor II (includes software for downloading results to a database)	DAVIS	http://www.davisnet.com/weather/products/weather_mon.asp	(510) 732 9229
Handheld Computer	1 ea				
Other Equipment					
Gas Generators	4 ea	Honda Super Quiet	Honda	www.hondapowerequipment.com	(800) 426-7701
Balances	3 ea			1 see note	
Weight Stations	3 ea			*see appendix??? for plans	
Lap Top	2 ea				

1 ASTM specifications call for a 1500 gram balance with an accuracy of 0.1 grams. High quality balances should be used and can cost as much as $1000.00 each. There are portable balances that are rechargeable and AC compatible. Choose a balance designed for outdoor use and extremes in temperature. They should be adjustable to level, equipped with a tare function, easily read, reliable calibration, and with a large top (panels being weighed are 12” by 12”).

Photo 3. Color Guide and LTL Readings

Photo 4. Surface Temperature Gauge, Weather, Wind

Photo 5. Generator

Photo 6. Tared Panels

1.2.1 Materials

Materials required for both the initial installation of the products and for required data collection are listed in the following table.

Table 2. Materials Table

Panels	Units	Recommended	Supplier	Contact	
12” by 12” by 1/16”	12	* Aluminum cut at local machine shop			
4” by 8” or 6” by 10” less than 1/16” thick	500				

1.2.2 Personnel

Table 3 shows the number of people needed to run a test deck by phase. The second column represents the people needed for the first phase or the initial application of the materials, the second phase represents the thirty-day evaluations, and the final phase represents the quarterly evaluations. Personal requirements quoted represent historical crew sizes and are a function of the available evaluation equipment used in each phase. For instance phase I is limited by the number of weight stations, phase II and phase III are limited by number of Retroreflectometers. Refer to Section 7 of the work plan for recommended evaluation procedures.

In the first phase, or the initial application phase, each of the vendors will require one person to assist them. This person’s duties will include calibration of the equipment, collection of samples and work zone protection as needed. The equipment person will have the responsibility of collecting weather data and recording and organizing data collected by the technicians working with the manufacturers. Counts listed for phase I reflect a typical deck where three weigh stations are in operation, total days for phase I are a function of the total number of products being installed on the test deck.

The second phase is listed in column three of Table 3. In this phase, the Technicians will be performing the evaluation of the products on a monthly basis.

Table 3 Required Personnel

	Phase I	Phase II	Phase III
Supervisor	1	1	1
Technician	6-7	4	4
Equipment	1	1	1
Total	8-9	6	6

Phase III of the operation will involve evaluation of the products on a quarterly basis.

Personal safety equipment is required and should include the following:

- Hard Hats
- Retroreflective clothing
- Safety glasses
- Gloves (both work and welding)
- Sun screen
- STOP/SLOW paddles (Flaggers)
- First Aid kits
- Full coverage shirts and pants
- Work boots

Training will be required for technicians before the beginning of phase I and will include training in the use of testing equipment, computers, scales, calculators and performing the computations required for calibration, placement, inspection and evaluations including durability criteria and measurement, and Work Zone and Flagger Training. Requirements and training resources are listed in Table 4.

Table 4. Required Training

Equipment	Training	Duration
Retroreflectometer	Flint Trading (Vendor)	4 hours
Spectrophotometer (Color Guide)	Flint Trading (Vendor)	1 hour
Weather Station	Manual	
Thickness Gauge	Manual	
Surface Temperature Gauge	Manual	
Weather Station	Manual	
Flagger Training	Local Technical Assistance Program	4 hours
Operations (placement, inspections, etc)	Supervisor	8 hours
Evaluations (durability, measurement)	Supervisor	4 hours

1.2.3 Vehicles

Vehicles required for each phase are listed in Table 5 Required Vehicles. The van required is a box van with enough room to install two desks, a file cabinet, and enough room to transport the evaluation equipment. The passenger van should seat at least five and will be used to transport personnel. The passenger car is required for the no-track test and to transport personnel. The four-runner is to be used to move technicians around the deck as needed.

Table 5 Required Vehicles

	Phase I	Phase II	Phase III
Van	**1**	**1**	**1**
Passenger Van	**1**	**1**	**1**
Passenger Car	**1**		
Four – runner	**1 (optional)**		

Photo 7. Test Deck Facilitator's Van

Photo 8. Van Work Space

Photo 9. Four Runner

Photo 10. Passenger Van and Passenger Car

1.3 Work zone

Work zone protection for all Phases of the project is identical. Protection should be supplied as outlined in the MUTCD for Stationary Lane Closure with Flagger attendance. Local standards should be referenced and will govern the Traffic Control Plan. It is recommended that the set up and removal of the Traffic Control Devices be contracted out and either billed directly to AASHTO or included in the contract as a bid item. See section five for Traffic Control Plan.

Photo 11. Workzone

1.3.1 Estimated application duration

Several items need to be considered in the estimation of time required to install the pavement marking materials and secondly to perform the evaluations. These items are listed below:

- Types of Products
- Number of Products
- Number of Manufactures

The type of products is the first consideration in determining the time required for the different phases. Paint products will be installed at a rate of three (3) to five (5) samples per day. Pre-formed tapes and Removable Tapes require less time per product and the average application

rate is five (5) products per day. Thermoplastics require a great deal of preparation and will average around three (3) products per day.

Utah T2 Pavement Test Deck Vendor Schedule Monday, June 11, 2001

ID	Task Name	Number of Product	Start	Finish	Duration
1	Lafarge Road Markings, Inc Mr. David R. Miller 404-767-0569 David Vallonie 770 - 479 - 6515	1- 45	7/16/01	7/25/01	10d
2	TMT - Pathway, Inc Mr. Richard Lazarus 503 - 364 - 2277	46 - 53	7/12/01	7/13/01	2d
3	Rohm and Haas Company Mr. Donald Schall 215 - 641 - 7163	54 - 64	7/24/01	7/27/01	4d
4	Ennis Paint, Inc. Mr. Kyne McCarty 1- 800 - 331 - 8118 ext 111 Mr. David Fitzgerald 404 - 351 - 9	65 - 72 75 - 79	7/9/01	7/12/01	4d
5	Avery Dennison Thermoplastic Mr. Derron Henderson 404 - 351 - 9780 ext 6116	80 - 87	7/20/01	7/23/01	4d
6	The RainLine Corporation Ms. Jennifer Marcato 334 - 277 - 0237	73 - 74	7/9/01	7/10/01	2d
7	Cataphote, Inc. Mr. Mark C. Terry 1 - 800 - 221 - 2574 ext 221	88 - 97	7/16/01	7/19/01	4d
8	Garlock Rubber Tech. Michele Hurt 870-215-4636	103 - 105	7/12/01	7/13/01	2d
9	Flint Trading, Inc. Ms. Kate Shelton 336 - 475 - 6600	98 - 102	7/12/01	7/13/01	2d
10	Trelleborg Burton J. Sutker 732 - 494 - 0723	106 - 112	7/12/01	7/13/01	2d
11	Prismo - Somerford Plastics Mr. Michael Lock (+44) 1260 - 0270918	113 - 114	6/7/01	6/21/01	15d
12	POLY - CARB, Inc. Mr. Kaushal Shah 440 - 248 - 1223	115 - 119	6/7/01	6/21/01	15d
13	Brite - Line Shae Durkin Technology 888 - 201 - 6448 ext. 1616	???	7/14/01	7/15/01	2d

Figure 1. Test Deck Vendor Schedule

Delay can be expected for the following reasons:

- Weather
- Equipment Failure
- Problems in materials being delivered to the deck
- Traffic congestion (e.g., crashes, holidays)

Weather delays can come in several forms. No products will be applied unless the surface has been dry for twenty-four hours and is greater than fifty (50) degrees farenheit. Secondly, high and low daily temperatures affect the calibration process, auto-no track time, performance of equipment, and performance of some products application. Manufacturers may choose to shut down their daily installation based on temperature extremes.

Equipment failure includes both manufacturers and test deck facilitators equipment. This is to be expected and is difficult to predict. Usually experienced manufactures will have extra equipment; however, this is not to be expected.

Given the above information, test deck facilitators should be able to develop a reasonable proposal. Reference Appendix 3 for a typical proposal.

SECTION TWO: NTPEP – SCHEDULING VENDORS

2. Scheduling Vendors - Introduction

This section will cover procedures for notifying vendors of their time slot on the deck. Recommended scheduling based on product types as well as coordination of installation between varying products will be covered. A Manufacturer's materials (e.g., shingles, roofing, paper) list will be developed and Manufacturer's responsibilities will be outlined.

Manufactures apply to AASHTO for the right to apply their products on a test deck. AASHTO then creates a list of products, each with a unique number, which is forwarded to the test deck facilitator. Products are numbered based on the host state, year of application, and a unique product number. For example "the first pavement marking material approved to be placed on the Pennsylvania test deck in the year 2000" may be given the number **PMM2000PA1**. Test deck facilitators shall be supplied with the Material Safety Data Sheets (MSDS), product technical bulletins, specifications and literature relating to the special handling and/or proper disposal of submitted products before product installation begins.

2.1 Scheduling Manufactures

The manufacturer's scheduled time on a test deck is based on the number and types of materials they will be applying. To avoid any perceived advantages or disadvantages that a manufacturer may have, an effort should be made to schedule manufacturers applying similar products at the same time. This is especially important when dealing with manufacturers applying temporary removable tapes.

Order of preference for scheduling product types:

1. Removable Tapes (Far end of test deck)
2. Paints (Beginning of deck)
3. Epoxies (In order)
4. Thermoplastics (In order)
5. Others…MMA (In order)
6. Preformed Tapes (In order)

2.1.1 Removable Temporary Tape Manufacturers

Removable temporary tapes are evaluated for six (6) consecutive months. Depending on the regional location of the test deck evaluations may be discontinued when winter weather prohibits the evaluation of the test deck. For this reason it is necessary to schedule the installation of removable temporary tapes early in the spring prior to the start up of the test deck or early in the spring the following year. Removable temporary tapes may be installed at the far end of the test deck in relation to the direction of application.

For test deck locations that allow for year round evaluation the following guide lines may be followed. Temporary tapes require a unique set of evaluations that must be performed approximately thirty days after their application. In many cases, a test deck application period will run for thirty days or longer. Therefore, it is recommended that manufactures of temporary removable tapes be scheduled to apply their products first. Scheduling manufactures of removable tapes first will assure that conditions for each manufacturer are the same. In addition, the first monthly evaluation can be accomplished towards the end of the initial application period. Removable tapes should be placed at the far end of the deck in relation to the direction of application.

Photo 12. Temporary Tapes

Photo 13. Temporary Tapes

2.1.2 Paint Manufactures

Paint manufacturers generally have the greatest number of products and should be scheduled early in the installation process. Three or more paint manufacturers may be scheduled at one time and may be scheduled at the same time as the removable tape manufactures. The auto-no-track evaluation is unique to paint products, the auto-no-track test site is situated at the beginning of the deck; therefore, paint products are generally installed as close as possible to the beginning of the test deck.

Photo 13. Paint Lines

2.1.3 Other Liquids Manufacturers (Epoxies, polyester, polyurea and other liquids)

Other liquid products should follow the installation of the paint products or be installed at the same time. The calibration process for other liquids is similar to that of paints therefore they will need to be close to the calibration equipment. Other liquids do not generally require the auto-no-track evaluation, due to their longer drying times; therefore they do not need to be at the beginning of the deck.

Photo 14. Epoxy Lines

2.1.4 Thermoplastics

Thermoplastics are time consuming to install for manufacturers. They follow the previously listed products only because there are generally not as many manufacturers installing these materials. Installation of these products does not involve a lengthy calibration process. They may be situated farther down on the deck and may be installed at the same time as earlier products with the availability of deck facilitators being the governing factor.

Photo 15. Thermoplastics

2.1.5 Preformed Tapes

Preformed tapes take some time to apply however they are not difficult for test deck facilitators to track and do not require much space or attention because they are pre-formulated materials. These products may be scheduled as “fillers” in the application process based on availability of test deck facilitators.

Photo 16. Preformed Tapes

2.2 Manufacturers Responsibilities – General

Manufacturers/suppliers must submit one Product Evaluation Form (PEF) for each sample product submitted; and one Traffic Paint Composition Form (TPCF) for each product submitted which has variable field formulation. The submittal package shall include Material Safety Data Sheets (MSDS), product technical bulletins, specifications, and literature relating to the special handling and /or proper disposal of submitted products. Manufacturers/suppliers must complete a Testing Fee Calculation Sheet (supplied by AASHTO). Calculated based upon the class of products and number of samples submitted to the program.

A complete product evaluation package shall include the following items:

- "Product Evaluation Form" (PEF) required for each product
- "Pavement Marking Identification Form" for each product classified as waterborne, solvent borne, thermoplastic or epoxy; or
- "Traffic Paint Composition Form" (TPCF) for each product;
- Signed copy of the ""General notes"
- Any product trade literature including : MSDS, material specifications, product trade bulletins;
- "Testing Fee Schedule" calculation sheet
- Material Safety Data Sheet (MSDS)
- Product technical bulletins
- Specifications
- Special handling and or proper disposal instructions
- Testing Fee Calculation Sheet

2.2.1 Field Testing and Evaluation Protocols

Manufactures/suppliers are required to install their own pavement marking materials on the test deck and should consider the following quantities as a minimum for application at each field test site based upon the class of material they intend to install:

• Liquid or Powder	19 Liters (5 gallons)
• Solid	23 Kilograms (50 pounds)
• Beads	14 Kilograms (30 pounds)
• Rolled or Flat Product (permanent)	152 mm x 49 m [(6 in. x 48 yd.)]
• Rolled or Flat Product (temporary)	152 mm x 87 m [(6 in. x 95 yd.)]

Glass beads supplied shall meet requirements for AASHTO specification M-247, Type I and will be supplied by the test state Department of Transportation (DOT). Beads shall be applied at the rate of 0/72 kg/L (6 lb/gal) of paint unless otherwise specified by the manufacturer and approved by the Test Deck Contact(s).

2.2.3 Manufacturers Equipment Lists

The following lists identify the equipment each manufacturer will need on site to aid in the setup, calibration, and clean up of the test deck site. This list does not include equipment for the actual application of the product.

2.2.3.1Temporary Tapes

- Heavy Duty garbage bags
- Shovel
- Broom
- Shipping container for samples

2.2.3.2 Paints

- Roofing paper
- Roofing Shingles
- Duct tape
- Two five gallon wash tubs
- Water
- Paint removal solvent
- Scrub brushes
- Heavy duty garbage bags
- Shovel
- Broom
- Four (4) one (1) quart corrosive resistant containers per sample

2.2.3.3 Epoxies, Polyesters, Polyureas, Methyl Methacrylate

- Roofing pager
- Roofing Shingles
- Duct tape
- Two five gallon wash tubs
- Water
- Solvent (for cleanup of removal of epoxies)
- Scrub brushes
- Heavy duty garbage bags
- Shovel
- Broom
- Four (4) one (1) quart corrosive resistant containers per sample
- Respiratory protection

2.2.3.4 Thermoplastics

- Roofing paper
- Roofing Shingles
- Duct tape
- Oven roasting pans (2 per product for samples)
- Marking pens
- Heavy Duty garbage bags
- Shovel
- Broom

2.2.3.5 Tapes

- Heavy duty garbage bags
- Shovel
- Broom
- Shipping container for samples

Note: Personal protective equipment shall be mandatory for admittance to the test deck site. This includes shirts with sleeves, long pants, hard hats, safety shoes, gloves, and safety glasses. Safety is of the utmost importance on an NTPEP Test Deck and no deviation from the required safety process will be tolerated.

SECTION THREE: WORK PLAN AND TRAINING OUTLINE

3.0 Field Testing Procedure and Field Testing Observations - Training

This Section will be based on the PennDOT experience in Field Testing Procedure and Field Testing Observations as outlined in the aforementioned Work Plan. In this section, the training requirements for the test deck facilitation crew and vendors will be detailed. This will include equipment operation, calculations, calibration, Flagger Training, and Work Zone Safety. Forms and tools for data collection will be provided. This section will be segmented in sections representing each type of material being applied.

3.1 Training

Test deck facilitators may require training in flagging procedures, operation of evaluation equipment, and procedural training pertaining to installation and calibration of equipment. Manufacturers that have not previously worked a test deck will require assistance in understanding their responsibilities as they apply to the installation of their product. This document will serve to familiarize them with what is required.

3.1.1 Test Deck Facilitators

Test deck facilitators are generally experienced with road work. The exception is the use of students working as interns, usually with backgrounds in engineering or science-related fields such as chemistry. Therefore, they are familiar with working with numbers and materials but may need guidance in safety-related matters as they apply to field operations. Areas that will require training and possible resources for training are listed below:

Training Needs	Training Resources
• Flagger Training	• Local Technical Assistance Program
• Retro-Reflectometers	• Supplier
• Color Guide	• Supplier
• Weather Station	• Users Manual
• Use of Balances	• Test Deck Supervisor
• Calculations- Calibration	• Test Deck Supervisor – Work Plan

3.1.2 Manufacturers

Manufacturers are generally skilled in the installation of their products. However, they may not have previously worked on an NTPEP pavement marking test deck. In some cases, manufacturers may subcontract to have their product installed on a test deck. Therefore, it should be expected that installers or manufacturers will have varying levels of experience in the installation process. Test deck facilitators are not responsible for training manufacturers in the installation of their products, but rather to ensure the products are installed in a safe and uniform manner as outlined in this work plan.

3.2 Site Location

Standard Practice for Conducting Road Service Tests on Fluid Marking Materials, ATSM D 713 – 90 gives the following guidance for Type and Location of Pavement for Tests:

> *" 4.1 Selected sections where traffic is moderate and free rolling with no grades, curves, intersection, or access points near enough to cause excessive braking or turning movements, where wear is uniform with full exposure to the sun throughout daylight hours, and there is good drainage. Select surfaces that are representative of the pavements upon which the fluid traffic marking material will be used in practice. Such surfaces include Portland cement concrete, sheet asphalt, bituminous concrete, rock asphalt, and bituminous surface treatment."*

Additionally, the following criteria shall be followed: Field test decks on both Portland cement concrete and bituminous concrete surfaces shall be evaluated. The decks shall be selected using the guidelines of ASTM D 713: "Select sections where traffic is moderate (minimum AADT 5000); free-rolling with no grades, curves, intersections or access point near enough to cause excessive braking or turning movements, where wear is uniform with full exposure to the sun throughout daylight hours, and areas which have good drainage." The test deck areas shall consist of sections which have been open to traffic at least one (1) year. Additionally, during the selection process, surfaces should be considered which have minimal cracking and/or pavement deterioration due to the long-term nature of these evaluations.

Other considerations in choosing a test deck location include concerns of user delays and noise pollution. Initially, a typical application of the test deck takes one lane out of service daily for a one-month period. Thereafter, during the first year, one lane is out of service from two (2) to

four (4) days per month depending on the number of markings installed. This accounts for considerable user delay costs. Consideration should be given to the day of week, times of day, and holidays when scheduling the test deck installation and inspections. Presently, the procedure for certain installation processes includes either slowing or stopping the traffic for short times. Hazards unique to test decks exist due to the area where the roadway markings are being installed. Working from the edge line to the skip line of the roadway places equipment and workers close to and sometimes into the open lane of traffic. For this reason the roadway chosen should have an outside shoulder wide enough to accommodate installation equipment and an inside shoulder wide enough that traffic can be shifted away from the skip line area. Generally this will require the roadway design to include a ten (10) foot outside shoulder and a four (4) foot inside shoulder.

Photo 17. Roadway With Wide Shoulder

Another area of concern is the sound and vibration set up by the placing of the markings in a transverse manner. Test deck areas create a sensation to drivers much like they experience from rumble strips. The sound generated by motorists passing over the markings can be annoying when test decks are placed too close to residencies. Steps that can minimize the impact of the test deck on local areas include static permanent signs in advance of the test site to warn motorists and public relation announcements on local radio stations and in newspapers prior to, and during, the initial application of the deck.

3.3 Conditions at Time of Application

Conditions at Time of Application include the following from ASTM D 713 – 90:

> *5.1 Clean the test area thoroughly of all foreign material. Do no apply traffic paint when the pavement surface is damp, wet or when the pavement temperature is below 50º F (10ºC). Application between 10 a.m. and 3 p.m. is recommended. During application record air and pavement temperature hourly.*

Cleaning the test area is the responsibility of the Manufacturer installing the product. Generally they will choose to broom off the area before product installation. Some manufacturers may use a compressor, sweeper, or other device to clean the area. All preparation should be noted by the test deck facilitator to include with information pertaining to the installation procedure for each product.

A guideline of 24 hours drying time has been set for the pavement marking product installation following a rainstorm. Some manufacturers may make installations before the end of the twenty-four hour period depending on the ambient temperature and whether or not they feel the surface is dry enough for their product. Although ASTM D 713 – 90 recommends the hours of application from 10 a.m. to 3 p.m., the ideal window of opportunity for application is based on existing local conditions. Usually manufacturers will be instructed to arrive at the deck at 9 a.m. and work as late as 5 p.m., if conditions permit. Hours of operation for the test deck facilitators usually run from 7a.m. to 7 p.m. including traffic control and generation of reports.

Recording of the air and pavement temperatures is accomplished with the use of a portable weather station and a surface temperature gauge. In addition to collection of the air temperature, the relative humidity must be recorded during the initial application. The weather station referenced in section two can be set to record ambient temperatures and relative humidity at varying intervals if the optional computer interface is purchased. This is the recommended method; a laptop will need to be dedicated to the task on a full time basis.

3.4 Equipment Criteria

Special equipment and specs are listed in this section. Approximate costs and equipment suppliers are listed in section two of this work plan.

- Manufacturer application equipment
- Balances
- Tarred panels
- Scales house
- Weather station set up and start time
- Thickness gauge
- Surface Thermometer

Manufacturers' application equipment varies with the type of product being applied. Application of paint fluid marking materials shall be by an appropriate spray applicator with traction drive and a spray nozzle similar to that used on normal marking equipment.

ASTM D 713 – 90 states the following qualifications for balances used in the calibration process of the paint application. "A balance must be immediately available and be thoroughly shielded from wind as well as be of 1500-g capacity with 0.1 gram or better sensitivity."

A Scale house constructed of plywood and Plexiglas has been designed for use on NTPEP Pavement marking test decks. Plans for the scale houses can be found in Appendix XX. Scale houses must be weighted down by sand bags, which shall be placed on the lower shelf. Scale houses are set up on the shoulder of the roadway so that the test deck facilitator faces the traffic when taking readings and making calculations.

Photo 18. Scale House

The balance is placed on the top shelf of the scale house and an electrical cord is run from the scale house to the generator through a hole in the side of the top compartment. If a portable, rechargeable balance is used. a generator will be necessary as a back up power source only. During the calibration process 12” by 12” by 1/16” panels will be placed on the balance and the door to the scale house will be shut to protect the equipment from wind.

Tarred panels used in the calibration process are recommended to be of the dimensions of 12” by 12” by 1/16”. Three or four sets of three panels should be constructed of aluminum or another rigid metal. Panels are supplied by the test deck facilitator and may be cut at a machine shop to precise dimensions but need not be laser cut. Panels should be grouped in sets that have similar weights and adjusted by filing the edges of heavier panel to create sets of equal weight. The weight tolerance in a set of panels shall be +/- 0.3 grams. Having sets of panels with equal weights allows the scale to be tarred at one weight rather than delaying the process waiting for a clean panel or resetting the balance for each panel used. Sets of panels shall have their weights calibrated periodically to ensure accuracy.

Photo 19. Tarred Sets of Panels

One weather station is required on the deck. Section two references the weather station most often used on test decks. These weather stations come with an option that allows for the information to be downloaded to a computer at predetermined intervals. Report outlines require that these intervals be set at one hour however most test deck facilitators will set the intervals at fifteen minutes. Both temperature and relative humidity shall be monitored by the weather station.

In addition to the ambient temperature and relative humidity the road temperature shall be recorded hourly. For the purpose of collecting the road temperature, an Infrared Thermometer with Laser Guide, such as the one referenced in section two, shall be used. This simple piece of equipment is a point and shoot configuration which operates on batteries. Each scale house location should be equipped with one of these units.

Photo 20. Weather Equipment

A thickness gauge will be required for verifying the thickness of thermoplastics and other liquid products applied. A 6" by 8" panel is laid in the path of the machine used to install a thermoplastic marking. When the material has dried the thickness of the line is determined by the reading obtained with a thickness gauge from the panels.

3.5 Material Criteria

The study will look at both liquid and preformed marking materials. These will include epoxies, methyl methacrylates, polyesters, polymeric films, thermoplastics and paints. For the paint portions of the study, AASHTO M 247, "Standard Specification for Glass Beads Used in Traffic Paint", type I moisture-proof beads applied at a rate of six pounds per gallon shall be used. Type I beads will be used on thermoplastic. The testing state shall provide testing reports for the Type I beads they provide. If a manufacturer wishes to use a special bead or a treated bead as part of a pavement marking system, it may be included in the test. Special coated beads are to be certified by the manufacturer as to reflective index, gradation, percent rounds, and type coating with methods recommended application rate. This rate is to be documented on all relevant test documents. Note that a bead may meet the specifications of an M 247 designation and still have varying coatings. For these reasons manufacturers supplying their own beads shall provide the required sample and testing reports for beads they supply. The certified methods for identification are to be sent to the State DOT that is doing the laboratory analysis for that particular field test site.

Experimental materials that are being developed by manufacturers may be installed as part of the field test. These materials will be limited to two (2) per manufacturer. There will be no laboratory tests conducted on these materials and only the field test data will be reported. The formulation of the material must accompany the submittal. This information will be kept in confidence by NTPEP unless directed otherwise by the manufacturer.

The field test material shall be installed during the months of May through August of each year. A manufacturer may choose to have a particular material field tested in only one or any number of the four sites nationwide.

3.5.1 Paints

Because of the vast number of conventional traffic paints that could be submitted for evaluation and testing, some limits may be set on quantity of products submitted. This determination will be made by AASHTO on a case by case basis depending on space available.

3.5.2 Fluid Marking Products Installation (Paints, epoxies…)

Installation of fluid marking products involves five (5) main steps:

- Site Preparation
- Sampling and Preparation
- Calibration
- Auto-no-track
- Application

Installation of a pavement marking product in a uniform and aesthetic manner insures an accurate and safe evaluation of the product. Each paint manufacturer will prepare an area for setting up their equipment. In this area, they will lay down roofing paper and run several test markings to assure that their equipment is performing properly. Once they are satisfied with the initial setup, they will notify the test deck facilitator that they are ready for calibration. Calibration requires that the manufacturer lay down another segment of roofing paper, placing a 12” by 12” by 1/16” panel on the roofing paper in the path of the application equipment and marking across the panel. The panel is then taken to the scale where it is weighed and tarred.

The thickness of the marking is then calculated, without beads. This process is repeated until the thickness of the marking is within acceptable parameters as outlined on the manufacturer's specification sheet. Next the manufacturer will include beads in a marking placed across the panel.

The pounds of beads per gallon will be calculated and iterations will continue until the beads per gallon meet the manufactures recommendations. At this point, the marking equipment is moved to the auto-no-track area.

3.5.3 Site Preparation

Site preparation involves laying out areas for the weigh stations and Manufacturer setup. Manufactures will need to be afforded ample space for their vehicles and equipment. The size of vehicles used by Manufactures varies from sports utility vehicles to larger fifth wheel vehicles. Depending on available space, the types and number of vehicles that a vendor brings onto the deck area may require restrictions. Areas assigned to paint manufacturers should be close to their assigned application area and near the auto-no-track test area.

Photo 21. Manufacture Site Preparation

Each manufacturer will have the responsibility of putting down roofing paper for the set up of their equipment during the calibration process. The equipment preparation area is usually

behind the manufacturer's vehicle on the shoulder of the roadway. Roofing paper for the calibration process is placed close to the weight station. The length of roofing paper put down should be long enough that the manufacturer can start and finish the application of a marking and note the performance of the application equipment. Most manufactures use duct tape to secure the roofing paper to the roadway.

Photo 22. Setup

Photo 23. Calibrations

Calibration of each product requires several iterations of the applications process. It will be the manufacturer's responsibility to clean each panel between applications. For this reason

manufacturers will be required to supply either solvent or water for the removal of the marking material from each panel. Generally manufacturers applying paint products will use two five-gallon tubs of water: one tub of water for detergent and one for a final rinse of the panels. Manufacturers of epoxies and other fluid marking materials will generally be able to clean the panels with rags and a solvent.

Each manufacturer is responsible for removal of their work debris, garbage, and hazardous waste from the worksite.

Photo 24. Clean Up

3.5.4 Sampling and Organization

After the manufacturer has reached his assigned work area he will unload his application equipment, supplies, and samples. If the test deck facilitator has not obtained a specification sheet on the products that will be applied that day, they should do so at this time. The specification sheet contains information that will be needed during the calibration process. Required information includes the weight per gallon, percent solids, color, and primer identification, bead identification, bead coating, and beads-lbs. per gallon. See Appendix 4 for Traffic Pavement Application Work Sheet.

Rather than setting up their equipment at the weigh station area, manufacturers will be expected to do preliminary adjustments and repairs at their assigned work area. This will keep the weigh station area clear for manufactures working through the calibration process.

Test deck facilitators shall ensure that all items necessary for calibration of the manufacturers' application equipment are made available. Facilitators shall be trained in the calculation process and proper operation of the scale, and use of surface temperature gauge. In addition they shall be equipped with the proper calibration and installation tracking forms (Appendix 4).

Prior to beginning the calibration process test deck facilitators shall obtain samples from the Manufacturer, fluid samples as well as beads. Manufactures are required to supply approved containers for their product. If MSDS sheets have not been supplied they shall be supplied by the vendor and accompany the samples. Under no circumstances should samples be accepted by test deck facilitators if they are not accompanied by the MSDS sheet for that product. Containers shall be marked with the Pavement Marking Number (PM) number assigned by the NTPEP administrator.

3.5.5 Calibration

Calibration of the manufactures equipment is important to assure that each pavement marking is placed at the manufacturer's specified thickness and lbs/gal of beads. This information is used by DOT's and other government agencies to compare the products they receive with those tested. The process is outlined in Part 6 and Part 7 of ASTM D 713-90 which are shown below:

"*Part 6 Measurement of Wet Film Thickness*

To aid in obtaining the correct film thickness, a length of roofing paper placed by the side of the road can be used. Place a rigid metal test panel on the roofing paper and in the path of the test line. A 12 by 12-in (300 by 300-mm) metal panel 1/16 in. (1.5 mm) in thickness is satisfactory. Immediately after the test line is applied by the motorized striper, read the wet film thickness. If the wet film thickness is not satisfactory adjust the spray thickness. If the wet film thickness is not satisfactory, adjust the spray pressure and repeat until the target wet film thickness is attained. It is important that no glass beads or other interfering materials be present that would give a false wet film reading. When the wet film thickness is correct, apply a test line across a tarred metal panel and weigh immediately. A balance must be immediately available and be thoroughly shielded from wind as well as be of 1500-g capacity with 0.1 g or better sensitivity. As a basis for determination of glass bead application (7.1) the weight of a paint line 4 by 12 in. (100 by 300 mm) (without consideration for solvent loss) can be calculated as follows:"

$$W = 0.0943 * t * g$$

W = weight of paint line, g,
t = mil thickness, and
g = weight per gallon, lb.

"Part 7 Measurement of Glass Beads

After the completion of Part 6, apply another test line to a tarred panel with the motorized stripper, this time also adding the glass beads, and weigh immediately. The weight difference between this measurement and that in Part 6 gives the amount of glass beads on the panel. The process can be repeated if an adjustment in the bead application rate is needed. The weight of applied glass beads can be calculated as follows:"

$$W = 1.418 * B$$

W = weight of glass bead, g, and
B = glass beads per gallon of paint, lb.

Four (4) beaded transverse lines will be applied per product. To check for actual thickness and weight, no additional drop-on beads are to be applied to the first three feet of these lines. Unless a manufacturer has requested to use a special coated bead, glass beads meeting requirements of AASHTO M 247 for Type I Beads (identified at the time of application) will be applied to the remaining length of these lines. These beads will be applied to paints at a rate of six (6) pounds per gallon and will be supplied by the field test deck DOT. The testing state will provide quality control test results for the beads provided. Additional beads installed that do not adhere to the material shall be removed prior to initial reflectivity readings. Special-coated beads are to be applied at the manufacturer's recommended application rate.

Photo 25. Calibration

Application of paint shall be by an appropriate spray applicator with traction drive and a spray nozzle similar to that used on normal marking equipment. Paint shall be applied at a thickness of 15 mils (+ - 1 mil). Application of these other materials shall be in accordance with the manufacturers recommended procedures and as similar as possible to that used on their normal marking equipment. The equipment shall have a speed adjustment that can be set during application. In addition, the application equipment shall have gauges for fluid pressure, atomizer pressure, bead pressure, and fluid temperature which shall be noted on the Traffic Pavement Marking Application Work Sheet.

Steps in the measurement of film thickness and bead amount are shown below:

1. Pre-weigh all panels (make four sets of three panels each, adjust the weights of each panel until they are equal by filing on a side that will not have marking applied).
2. Apply the line across the entire panel.

3. Reweigh the panel.
4. Subtract the pre-weight of the panel (the remainder is the weight of the panel).
5. This weight should be compared to the calculated range derived as follows:

   I. Length of line X width of line X thickness of line = A
   II. Conversion factor to metric = 0.12 = Kg/liter = B
   III. A X B = C
   IV. C X wt/gal(lb/gal specific to product = Upper Weight Range
   V. C X wt/gal X %solids = Lower Weight Range

Bead Weight Calibration – Once the paint weight has been achieved within the range, add the appropriate weight for the glass beads over the length of the line.

6. Six (6) lbs of glass beads on a 12" by 4" fluid line weighs 8.5 grams. For other dimensions use a simple proportion to calculate the weights.

   For example: Given a 4" by 4" paint line;

$$\frac{8.5 grams}{12 in} = \frac{x grams}{4 inch}$$

$$x = 2.8 grams$$

3.5.6 Auto No Track (Paints Only)

The auto-no-track area is the first test section on the deck. After the completion of the calibration process, the auto-no-track is performed. In the auto-no-track area the manufacturer will put down a marking from the edge line to the centerline of the roadway. At a time interval, typically 30, 60, or 90 seconds, chosen by the manufacturer the test deck facilitators will pass over the line at a speed of fifteen (15) mph. It is important that the speed of the vehicle is constant with no braking or acceleration over the marking. After the car has passed over the marking a facilitator standing 50 ft. upstream from the marking makes a visual inspection to determine whether or not the marking has tracked. If the marking has tracked, the manufacturer is given the opportunity to increase the auto-no-track time and have the evaluation repeated.

Photo 26. Auto-No-Track Area

9.1 Auto-No-Track Time" The auto no-track time id determined by passing over the freshly applied line in a simulated passing maneuver with a standard size passenger car with regular treads (no snow treads). A line showing no visual pick-up and redeposition of the materials onto the pavement surface when viewed from a distance of 50 ft (15m) in the highway direction is considered as showing nor pick-up an conforming to the drying time requirements.

9.1.1 The test line is applied at the same temperature, the same wet film thickness, and the same rate of glass beads as will be specified by the purchaser in production application.

9.1.2 The no-track maximum time is measured when the pavement temperature is from 60 to 120 degrees Fahrenheit (15 to 50 degrees Fahrenheit) and under local humidity conditions, providing that eh pavement is dry.

3.5.7 Installation

After finishing the auto-no-track, the manufacturer will proceed to the sub-decks that have been assigned for their products. Two sub-decks separated by one deck are assigned for each product. Each of the assigned decks will be marked twice with parallel markings, placed as close together as installation equipment will allow. Marking must be placed from the edge-line to the far side of the skip line. Evaluation areas for markings are eighteen (18) inches of the left wheel path and nine (9) inches beginning from the projection of a line extending between existing skip lines. Manufacturers will often choose not to place markings across cracks in the highway or any other unusual surface blemishes or contaminants. No placement of a transverse evaluation line shall cross an existing skip line road marking in perpendicular fashion.

Photo 27. Paint Installation

3.5.8 Thermoplastics

Thermoplastics shall be applied in accordance with the recommendations of the manufacturer. The material manufacturer shall provide detailed written information regarding application procedures used. The bead application rate for fluid materials will be measured according to ASTM D 713-90. For application where the beads cannot be properly measured, the line will be flooded with beads. The minimum mil thickness for thermoplastic material tested shall be 30 mils (+-5 mils). The widths of lines of materials with thicknesses greater than 20 mils, except removable tapes, shall be 6 inches.

Application of thermoplastics have three (3) main steps:

- Site Preparation
- Sampling and Preparation
- Application

Manufactures will be required to tape roofing paper onto the shoulder of the roadway in their assigned setup and work area. This section of roofing paper should be used for preparation and sampling of the product.

Photo 28. Thermoplastic Set Up

Thermoplastics require the manufacturers to heat the product to extremely high temperatures. Once the manufacturer has his sample at the correct temperature for application the manufacturer will fill one (1) roasting pan with a portion of the marking material from the application equipment to obtain fifteen (15) pounds of the product for shipment to the lab. The pan will be set aside until the product is cool.

Photo 29. Thermoplastic Machine

Photo 30. Thermoplastic Sample

The manufacturer will be required to apply four (4) lines; however, the sample will only need to be taken once for each product. Each product will be applied in pairs on two sub-decks separated by one sub-deck. This is in anticipation of some lines being destroyed by crashes or unforeseen circumstances.

Once the area where the markings will be applied has been determined, a 4” by 8” panel of less than 1/16” steel will be laid in the path of the application machine in the first third of the lane measured from the edge line.

Photo 31. Metal Panel in Place

The manufacturer will place the marking from the edge line to the skip line across the panel. Once the panel is cool, the thickness of the line may be determined using the thickness gauge.

3.5.9 Preformed Thermoplastics and other Tapes

Application of preformed thermoplastics and other tapes (with the exception of removable tapes) is a straight forward process. The manufacturer will be required to apply four (4) transverse lines, two (2) parallel lines per sub-deck with a sub-deck in between. This is in anticipation of some lines being destroyed by crashes or unforeseen circumstances.

Test deck facilitators should monitor the process noting the application preparation. Any special treatment of either the surface or the product being applied should be noted. Some products require the surface to be heated or treated with solvents. Other things to note include heating the tape to a certain temperature and rolling the product with weighted rollers.

Note: Metal panels should not be used for measuring thickness of preformed thermoplastics because this will give inaccurate results.

3.5.10 Removable Tapes

Removable tapes are applied in sets of six transverse and six longitudinal lines of markings. The six transverse markings are placed parallel to one another on the same sub-deck. As with other installations the transverse lines will be twelve (12) feet long. The six longitudinal markings are placed in pairs, with 2" of separation, ten (10) feet long, parallel to existing skip lines.

Photo 32. Removable Tapes (Longitudinal)

Photo 33. Removable Tapes (Transverse)

Photo 34. Removable Tapes (Longitudinal)

SECTION FOUR: SAMPLING

4.1 Sampling

This section will be based on the PennDOT experience in Laboratory Evaluations. Collection and shipping of samples to Labs for evaluation will be covered in detail, both from the perspective of handling hazardous materials and the timeliness of handling. Tests and specifications will be listed for use by Labs.

4.2 Tests and Specifications of Lab Tests

Certain standard tests should be used to evaluate pavement marking materials. Some non-standard procedures may also prove valuable to assure that materials procured by users are of the same quality as those on the test deck.

As a result of stated concerns about the possible publication of erroneous laboratory data, each manufacturer may supply a listing of anticipated laboratory results with their application. During laboratory evaluation, should significant differences be observed between laboratory results and the anticipated results, the manufacturer will be notified and the matter will be resolved. Before this procedure is observed, a list of acceptable ranges for each laboratory evaluation procedure must be submitted by industry and accepted by the NTPEP Pavement Marking Materials Project Panel.

In dealing with traffic marking paints, there are certain tests that are used regardless of the type of paint being used. These would include the following tests:

1. Viscosity for consistency
2. Drying time to determine no pick-up condition
3. Solids content by volatile loss
4. Opacity for hiding power
5. Pigment content by low temperature ashing for waterborne paint and high speed centrifuge extraction for solvent borne paint.

Vehicle quality assurance in solvent borne paint can be obtained by comparing infrared scans on the vehicle portion of the high-speed centrifuge extraction.

Three other tests relative to water emulsion paints deal with stability and accelerated weathering. The water resistance is a standard test for a number of weather related failure characteristics. The stability tests are a means of determining the stability of water-emulsion paints to cycling of hot and cold installations. These stability tests are described in Note 1 and Note 2.

Table 6 and Table 7 are listings of the applicable ASTM specifications for testing both solvent-reduced and water-emulsion paints.

Table 6. Solvent Borne Paint

SOLVENT BORNE PAINT	
TEST	**ASTM SPEC**
Viscosity	D 562
No Track Dry Time	D 711
Total Solids	D 2369
Pigment Content	D 2698
Opacity	See note 4
Setting Properties	D 868
I. R. Scan on Vehicle	D2621 (Used to Produce Standard Curve)
Density, LBS/GAL	D 1475
X-Ray Diffraction	Drive Film Scan* (Used to Produce Standard Curve)

Table 7. Water Borne Paint

WATER BORNE PAINT	
TEST	ASTM Spec
Viscosity	D 562
No Track Dry Time	D 711 (See Note 6)
Total Solids	D 2369
Pigment Content	D 3723
Heat Stability	See Note 1
Freeze – Thaw Stability	See Note 2
Water Resistance	See Note 3
Opacity	See Note 4
Density, LB S/GAL	D 1475
Setting Properties	D 869
X Ray Diffraction	Dried Film Scan* (Used to Produce Standard Curve)

Note 1 – Heat Stability:

Put 450 ml of point in a 373 ml (1 pint) lined container, close the container, seal it with tape and put it in an oven maintained at 60 +- 1 degree C for one week. Equilibrate the paint at 25 +- 1 degree C and mix thoroughly with gentle stirring. Perform the consistency test as specified in ASTM D 562. Note the difference in consistency in KU.

Note 2 - Freeze–Thaw Stability:

Put 450 ml of paint in a 473 mL (1 pint) lined container, close the container, invert, and place in a chamber maintained at -10 degrees +- 1 degree C. Remove the container after 16 hours and maintain at 250 degrees +- 1 degree C for 8 hours. Repeat this procedure four more times. At the completion of the freeze-thaw cycles, equilibrate the paint at 25 degrees + 1 degree C, mix thoroughly with gentle stirring, and examine for smoothness and uniformity. Repeat the consistency tests as specified in ASTM D 562. Note the difference in consistency in KU and note any evidence of coagulation of the paint or breaking of the emulsion.

Note 3 – Water Resistance:

Apply the pint on a clean glass plate, to a wet film thickness of 15 mL (0.015 inch) with the use of a doctor blade and allow to dry in a horizontal position at 25 degrees +- 1 degree C for 72 hours. Immerse one half of the painted plate in distilled water at 25 Degrees +- 1 degree C. After 18 hours, remove the paint from the water and allow to dry for 2 hours at 25 degree +- 1 degree C. Examine for softening, blister wrinkle or loose adhesion.

Note 4 – Dry Opacity and Color:

Dry Opacity = Reflectance Over Black/Reflectance Over White

The dry opacity of the paint shall be determined as follows: On a black-white Lenata Form 2C Opacity Chart draw down a 15 mil and 5 mil wet thickness film covering the black and white portions of the chart. Dry the specimen for 24 + 1 hours at 25° + 1° C. Using a spectrocolorimeter with CIE 2° observer and Illuminant D65, determine the reflectance over the black and white areas of the chart. The Dry opacity is determined by dividing the reflectance over the black by the reflectance over the white. Measure the color of the dried film using 2 degrees observer and Illuminant D 65. The resulting CIE lab color scale values and/or the Yxy values shall be reported.

Note 5:

Five (5) grams or pigment of the solvent-borne paint will be collected and retained during the time of testing. A one quart wet sample of the sample of the water-borne paint will be retained. These samples will be available for those states wishing to analyze the pigment of a specific paint. The states will then provide the testing laboratory with the analytical data, where it will be kept on file for future use.

Note 6 – Alternate No Track Dry Time (Water-Borne Paint)

Draw down paint on clean glass plate at various depths using an adjustable doctor blade. Determine which wet film thickness yields a completed dry film thickness of 7 to 8 mils. Fill the bottom of a Paul N. Gardner Co. test chamber, Model WE-HTAB-1 76, with ¼ to ½ inch of

water, close all ports and door and allow to equilibrate overnight. By carefully opening and closing the ports, establish a relative humidity of 90 +- 3% inside the chamber. Record the temperature and the relative humidity inside and outside the chamber. On clean glass, draw down 2 test panels of the predetermined wet film thickness which yields a dry film thickness of 7 to 8 mils. Promptly place the wet films in the test chamber and adjust and maintain the relative humidity at 90 +- 3%. Touch the films at 15 minute intervals until the finger does not pick up wet paint. Then begin dry-through testing outside the chamber at 15 minute intervals. The film is dry through if it does not distort from a 900 thumb twist with out pressure on the film. Record temperatures, relative humidity's, and times. Measure the dry thickness of the paint. A control or standard paint should be tested every day that dry-through time tests are conducted.

4.3 Thermoplastics

Testing of Thermoplastic by procedures set out in AASHTO are designed to evaluate the effects of continued and repeated heating of the material; its ability to withstand temperature changes and still retain its bond to the substance to which it is applied. These tests include:

Table 8. Thermoplastic

THERMOPLASTIC	
TEST	AASHTO TEST METHOD
Specific Gravity	T250
Flowability	T250
Flowability (Extended Heating)	T250
Softening Point, Ring and Ball	T250
Low Temperature Stress Resistance	T250
Bead Content and Grading	T250
Impact Resistance	T250
Daylight Reflectance	T250
Yellow Index	T250

4.4 Epoxy

The testing of Epoxy is designed to evaluate and determine drying time, epoxide number, and adhesion to concrete, hardness, abrasion resistance, and color retention. Table 9 provides an outlines of these tests and the test methods.

Table 9. Epoxy

EPOXY	
TEST	TEST METHOD
Drying Time	ASTM D 711
Epoxide Number	ASTM D 1652
Adhesion to Concrete	ACI Method 503
Hardness	ASTM D 2240
Abrasion Resistance	ASTM C 501
Color	ASTM G 53
Yellowness Index	ASTM D 1925

4.5 Preformed Polyneric Tapes

Cold applied polymeric tapes are better field evaluated, but they should be examined for internal strength to assure that excessive elongations of distortions does not take place. Table 10 provides a list of tests for this class of product.

Table 10. Preformed Polymeric Tapes

PREFORMED POLYMERIC TAPES	
TEST	ASTM TEST METHOD
Tensile Strength	D 3759
Ultimate Elongation	D 3759
Retroreflectivity	D 4505
Whiteness Index	E 313
Adhesion	D 4505
Skid Resistance	D 4505 (Does not apply to preformed thermoplastics)
Wear Index	Fed. Test Method 141 & 6192.1, using a CS17 wheel and 1000 g load

Laboratory evaluation of the more sophisticated or exotic pavement marking materials should be made for reference purposes and as set out in manufacturer's product data information.

4.6 Sample Shipping Procedure

- Account for all samples to be shipped, and prepare shipping lists for same.

- Assure all samples are clearly labeled and of size or quantity as required by the current work plan for testing.

- Package, per related labels, into labs cloth aggregate bags and clearly mark with NTPEP PMM number, which samples are in each bag. Tie bags with heavy cord string. As a secondary ID of samples in bag, attach a card with NTPEP PMM number, Product ID, etc. to cord string.

- Each of the following bullets shall be packaged and shipped in separate containers/crates:

    - For removeable or non-removeable tapes, cut to required length (16 feet +), reroll and tie with cord string using ID card with appropriate labels. Package into bags as above and label outside of bags accordingly. The remainder of material sampled (over 16 feet) shall be retained by state testing lab for future reference or retesting as required. After preparing all removeable and non-removeable tapes, hot tapes and thermoplastic samples, locate or construct and weigh a shipping box large enough to include all samples. Box should be forklift compatible and with lid. After weighing and packing in all samples, and including a shipping list and a copy of the MSDS sheets of all samples in the box, seal lid and strap with metal shipping straps. Attach address labels to outside of box as required. Inform shipping and handling department to prepare arrangements as required.

    - For samples of polyester, epoxy and MMA's, which are usually in metal cans or plastic bottles, assure all samples are properly labeled and sealed. Package into heavy cardboard boxes, which can be handled by one person, and include a shipping list and a copy of MSDS sheets of all samples boxed. If shipped by commercial carrier, hazardous procedures for packing (including absorbent materials) and shipping will apply.

    - For samples of adhesives, primers and surface preparations, assure all samples are properly labeled and sealed. Samples should be identified with corresponding PMM # (s) to facilitate proper sample tracking/testing. These are hazardous materials and will need to be packed (including absorbent materials) and shipped as per shipping and handling for hazardous materials. Send to same address as tapes, hot tapes and thermoplastics. Include shipping list and MSDS sheet of all samples.

During the application period of the Traffic Pavement Markings:

1 Make charts for all the Companies Products.

2 Sample all products at time of application, and make sure they have proper labels on each sample. (NTPEP Identification Number, Product Identification, Company Name)

3 Make sure you have MSDS sheets for all products that are needed.

4 Log all products into the chart to make sure all the products are sampled.

5 Take all samples to the Dot Maintenance area to be stored under lock and key for safety, daily.

6 Transport the samples to the area where they are going to be shipped out of as scheduling permits.

Getting samples ready to be shipped to the Laboratories for testing:

1 Make sure all samples are properly labeled before they are boxed for shipping.* (NTPEP Identification Number, Product Identification, Company Name)

2 Box all products, keep all companies products together, of the same type (paint, epoxy, thermoplastic, etc.) All tape products can be individually bagged and indentified

3 Keep all the adhesives and primers boxed separate from the product samples.

4 Put MSDS sheets in the box with the appropriate samples and also have a copy of the MSDS sheets put in an envelope to be given to the Shipping Agency. Third set retained by host state for reference. Include complete manifest list of shipment which includes NTPEP ID #, Product ID and Company Name

5 Box or crate all products on a skid, keep all products together, of the same type (paint, epoxy, thermoplastic, etc.) to be sent to the different testing agencies.

6 After the samples are all crated on skids according to the different testing agency destinations, weigh each of the testing agencies skid (s) to get the total weight for shipping.

7 Contact appropriate shipping agency to get price to ship the samples to their destination.

8 After you get the price to ship the samples, get the paper work completed to pay for the shipping.

9 Contact the appropriate shipping agency to pick up the samples for shipment.

10 Contact each of the testing agencies and let them know that the samples are being shipped.

11 Confirm shipment by follow-up call to testing agency.

* Packaged and ship products in the quantities and volumes as specified by workplan. Remainder (if available) shall be retained by host state for replacement, retest purposes.

Section Five: On Site Test Deck Preparation

5. On Site - Deck Preparation

This section will cover laying out the deck site, mapping the deck, and preparing a Traffic Control Plan. Numbering and labeling the decks, auto-no-track area, sub-decks, advance warning signs, and parts of the work zone will be covered in detail.

5.1 Deck Mapping

The following from ASTM D 713 outlines the type and location of the pavement for the test deck location.

> *4.1 Select sections where traffic is moderate (minimum AADT 5000) and free rolling with no grades, curves, intersections, or access points near enough to cause excessive braking of turning movements, where wear is uniform with full exposure to the sun throughout daylight hours, and there is good drainage. Select surfaces that are representative of the pavements upon which the fluid traffic marking material will be used in practice. Such surfaces include Portland cement concrete, sheet asphalt, bituminous concrete, rock asphalt, and bituminous surface treatment. (Test deck areas shall consist of sections which have been open to traffic at least one (1) year. Preferably two years.*

Based on the above information, two segments are selected for application of the products. One of the areas will have an asphalt surface and the other will be Portland concrete cement. Ideally the two types of surfaces will be in the same direction of travel within the same segment of roadway. This is seldom possible due to the differing surfaces, and test decks are usually along a multilane roadway in opposite directions of travel separated by a median. For all other parameters met, this is acceptable. The average annual daily traffic (AADT) of the two directions of travel should be verified to be similar.

Photo 34. Asphalt

Photo 35. Concrete

Test deck operations for cases where the two types of surfaces are on the same segment of roadway operations may be performed within the same work area. For test decks operations where the surface types are either separated by some distance or are on opposite directions of travel, one deck surface is worked one day and the other deck surface is worked the following day.

Determination of the required length of the test deck is based on the number of products being applied on the deck. Removable tapes require the largest area per product. They require not only a longitudinal application between skip lines but also a transverse application parallel to

the skip lines. Each removable product requires three skip lines. Test deck facilitators should verify that the length of the work area will contain enough skip lines to meet the requirements of the approved removable products being installed. Beyond the question of the number of skip lines required for the removable products, the deck needs to be long enough to handle the number of other products being applied between the skip lines.

The tests performed on the products are done within eighteen (18) inches of the left wheel path and within nine (9) inches of the skip line area. No marking will be placed abutting (or directly perpendicular to) an existing skip line. Disregarding the areas required for the temporary tapes, the length of the roadway segment for each surface type and each product applied under ideal conditions is equal to the width of the line being applied four times, with some distance in between to avoid the marking being affected by the next marking being installed. This distance is generally six (6) inches. Therefore each product (4-inch line) will require, at a minimum, forty (40) inches of roadway (four (4) lines with six (6) inches between each line). This is a minimum distance and is affected by the condition of the surface and the success the manufacturer has installing the product. Surface blemishes such as cracks or joints will be avoided by the manufacturer in installation of their product. Also, any foreign matter on the surface that cannot be easily removed may affect a products adhesion to the surface. Therefore, a manufacturer will be looking for conditions as ideal as possible for the application of their product. Difficulties with equipment or product mix may be a cause for an unacceptable marking. It is the manufacturer's prerogative to accept each line as long as they make that decision the same day the marking is applied.

Photo 36. Rejected Line

When considering the total length of the deck it is advisable to allow for twice the actual area required for the number of markings being applied. Generally the area between skip lines is three (3) times the length of the skip line or thirty feet long. Each deck is broken down into sub decks. Each sub deck is eighty (80) feet long and includes two (2) skip lines. The sub deck runs from the beginning of one skip line to the beginning of the second subsequent skip line. In this way each sub deck consists of sixty (60) feet of usable area for the application of transverse markings. When markings are applied they are applied in pairs with one sub deck between each pair. Each sub deck is given a unique number for that particular deck and each marking is given a unique number for each sub deck. For example a marking may be referenced on a particular deck as 1-1, this would indicate that the marking is on sub deck one and it is the first marking on that deck. For example the complete installation of a particular product may have the marking numbers 1-1, 1-2, 3-1, and 3-2. This would indicate that this product had two (2) markings on sub deck one and two (2) markings on sub deck three in the number one and number two positions on each sub deck. Mapping the deck in this manner is important for referencing in the collection of evaluation data.

There are different schools of thought on the direction that the test decks should be worked. Some test deck facilitators prefer to work the deck with the direction of travel while others choose to work the test deck against the current of traffic. This is a safety issue in planning of the installation of the product and further evaluations. Working against the current of traffic

may afford workers a better view of oncoming traffic while applying their products or performing evaluations.

Whichever direction of work is chosen, the sub decks should be numbered with the direction of work. Numbering of the sub decks is done in the field with an approved traffic marking paint color on the shoulder of the roadway at the beginning of each sub deck. Numbering is done sequentially and numbers are large enough and are placed where they can be plainly seen from a vehicle traveling on the shoulder of the roadway. It should be kept in mind that the numbers will be needed for as long as three (3) years. This will require a durable marking material and will need to be refreshed periodically. Numbering of each marking will also need to be done. Again this numbering shall be done with the direction of work, shall be sequential for each sub deck and is required to identify unique markings over the life of the test deck.

It is advisable to choose a beginning number for each segment between skip lines. For example, for each sub deck the beginning marking number between the first two skip lines will be one (1) and the beginning number following the second skip line will be forty-five (45). This is in case two (2) manufacturers are applying products on the same sub decks at the same time, and the ending number between the two previous skip lines is not yet known. Depending on the type of marking, the numbering may either be embedded in the marking material or it may be marked with an approved color of traffic marking fluid. If the marking is made with traffic marking fluid, the numbering shall be placed on the shoulder side of the edge line marking in line with the referenced marking. Placing the marking on the edge line may result in the numbering system being obliterated by maintenance crews while renewing existing edge line markings.

Photo 37. Sequential Numbering

Mapping of the deck in the above manner allows for the test deck facilitator to create an Excel spread sheet, which can be easily maintained and referenced when collecting evaluation data. Most of the equipment used in the evaluation process stores the data for the entire deck as it is being collected. When collection has been completed, the information is downloaded immediately onto a laptop computer, verified for completeness, and pasted directly into the spread sheet "map" of the deck. This process assures the quality of the evaluation numbers collected.

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	line_id	sub_deck	deck_id	pmm	date	skip_rr	wheel_rr	color_biq	color_x	color_y	skip_dur	wheel_dur	pict
2	1	1	1001	1	7/27/2001	325	385	59.86	0.3543	0.3608	10	10	1-1.jpg
1	line_id	sub_deck	deck_id	pmm	date	skip_rr	wheel_rr	color_biq	color_x	color_y	skip_dur	wheel_dur	pict
2	1	1	1001	1	7/27/2001	325	385	59.86	0.3543	0.3608	10	10	1-1.jpg
3	1	3	1001	1	7/27/2001	326	350	67.63	0.3219	0.3406	10	10	3-1.jpg
4	2	1	1001	1	7/27/2001	351	391	68.87	0.3222	0.3409	10	10	1-2.jpg
5	2	3	1001	1	7/27/2001	268	385	70.75	0.3215	0.3402	10	10	3-2.jpg
6	57	9	1001	100	7/27/2001	526	396	68.12	0.3192	0.3411	10	10	9-57.jpg
7	58	9	1001	100	7/27/2001	498	455	66.31	0.32	0.3419	10	10	9-58.jpg
8	59	11	1001	100	7/27/2001	495	473	64.64	0.32	0.3419	10	10	11-31.jpg
9	60	11	1001	100	7/27/2001	486	362	63.77	0.3209	0.3428	10	10	11-32.jpg
10	59	9	1001	101	7/27/2001	243	235	34.9	0.4693	0.4359	10	10	9-59.jpg
11	60	9	1001	101	7/27/2001	258	249	35.75	0.4694	0.4366	10	10	9-60.jpg
12	61	11	1001	101	7/27/2001	257	220	35.64	0.4681	0.4365	10	10	11-33.jpg
13	62	11	1001	101	7/27/2001	229	212	35.65	0.4693	0.4373	10	10	11-34.jpg
14	55	8	1001	102	7/27/2001	221	243	49.81	0.3132	0.3367	10	10	8-55.jpg
15	56	8	1001	102	7/27/2001	209	226	50.99	0.3147	0.3373	10	10	8-56.jpg
16	60	6	1001	102	7/27/2001	298	254	47.65	0.3127	0.3362	10	10	6-31.jpg
17	61	6	1001	102	7/27/2001	287	215	45.24	0.3153	0.3387	10	10	6-32.jpg
18	61	8	1001	103	7/27/2001	198	184	30.76	0.4985	0.4363	10	10	8-61.jpg
19	62	8	1001	103	7/27/2001	267	224	31.84	0.4966	0.4369	10	10	8-62.jpg
20	66	6	1001	103	7/27/2001	220	203	31.45	0.5011	0.4378	10	10	
21	67	6	1001	103	7/27/2001	237	238	31.82	0.4987	0.4391	10	10	
22	21	2	1001	104	7/27/2001	228	226	27.95	0.4916	0.4375	10	10	2-21.jpg
23	21	4	1001	104	7/27/2001	240	228	29.03	0.4906	0.4387	10	10	4-21.jpg
24	22	2	1001	104	7/27/2001	287	309	28.34	0.4925	0.4381	10	10	2-22.jpg
25	22	4	1001	104	7/27/2001	306	307	29.48	0.4923	0.4398	10	10	4-22.jpg
26	57	8	1001	105	7/27/2001	225	241	51.41	0.3122	0.3358	10	10	8-57.jpg
27	58	8	1001	105	7/27/2001	310	296	46.57	0.3144	0.3376	10	10	8-58.jpg
28	62	6	1001	105	7/27/2001	291	270	45.01	0.3098	0.3338	10	10	6-33.jpg
29	63	6	1001	105	7/27/2001	410	372	49.61	0.3141	0.3362	10	10	6-34.jpg
30	59	8	1001	106	7/27/2001	184	216	31.04	0.4953	0.4351	10	10	8-59.jpg
31	60	8	1001	106	7/27/2001	217	222	31	0.4959	0.435	10	10	8-60.jpg
32	64	6	1001	106	7/27/2001	185	178	30.53	0.4953	0.4347	10	10	6-35.jpg
33	65	6	1001	106	7/27/2001	232	223	31.64	0.4967	0.4361	10	10	
34	7	5	1001	11	7/27/2001	443	448	63.26	0.3196	0.3431	10	10	5-7.jpg
35	7	7	1001	11	7/27/2001	451	413	65.94	0.319	0.3422	10	10	7-7.jpg
36	8	5	1001	11	7/27/2001	465	441	62.95	0.3194	0.3427	10	10	5-8.jpg
37	8	7	1001	11	7/27/2001	411	411	65.58	0.3188	0.3422	10	10	7-8.jpg
38	10	5	1001	12	7/27/2001	211	191	40.73	0.4734	0.4446	10	10	5-10.jpg
39	10	7	1001	12	7/27/2001	200	197	40.81	0.4732	0.4439	10	10	7-10.jpg

tracking_pmm

Figure 2. Excel Spread Sheet Map of Deck

Prior to the sub-decks used in the application process is the area where the auto-no-track is performed. This area is used to test the drying time of paint products and is placed at the beginning of the test deck. Within this area the manufacturer places paint marking which are driven over by a passenger car after a specified time by the Manufacturer to determine the time it takes for the product to dry. Manufacturers may make several passes applying each product until a drying time has been determined. Again, this area is generally between skip lines and the length is dependent on the number of paint products. Past experience has shown that that the number of passes a vendor makes usually does not exceed three (3) times. The markings placed for the auto-no-track shall be numbered outside the edge line on the shoulder side of the roadway.

5.2 Traffic Control Plan

Test decks have some unique properties that must be addressed in the formulation of the traffic control plan and in the safe operation of the deck, both in the initial application and subsequent evaluations. At the auto-no-track area the manufacturer is required to start marking at the skip line and mark from the skip line to the edge line at an angle equal to the angle a vehicle would pass over a freshly painted skip line in a production application. This requires that the manufacturer move his equipment out into the lane that the traffic is occupying for some time. Therefore, the test deck facilitator is required to stop traffic while the manufacturer is fouling the centerline. This means that a flagger will be required at this location while the paint products are being evaluated for tracking.

Photo 38. Flagger

Manufacturers are required to place markings from the edge line of the roadway up to and including the skip line area. In order for this to be done, the manufacturer will again foul the skip line area for a brief time. During the application, the manufacturer will be intent on the performance of the application equipment and will be unable to view oncoming traffic. Therefore traffic will again need to be stopped to accommodate the application of each marking. Generally, the way this is accomplished is with the use of a flagger who coordinates with the manufacturer to make the application with as little delay to motorists as possible. Once the manufacturer is prepared to place the marking the flagger is signaled. The flagger will wait for

a gap in traffic based on the volume of the traffic that will delay traffic as little as possible. However, depending on the volume of the traffic, some delay can be expected.

In addition to fouling the live traffic lane during the auto-no-track and in the application process, the skip line area is again fouled when the evaluation of the marking in the first nine (9) inches of the skip line area is performed. Usually this can be addressed with a minor encroachment of the live lane by moving the traffic control devices outside of the skip line area and squeezing the traffic onto the inside shoulder of the roadway. Experience has shown that a flagger equipped with a stop slow paddle is still required. This flagger has the responsibility of communicating with those employees taking the evaluation readings. Again, this is important because the technicians taking these readings will be intent on the operation of the evaluation equipment. This operation can be accomplished with the paddle turned to slow and flagger focusing on the speed and attentiveness of passing motorists. If at some time an errant vehicle drives into the area that evaluations are being made, it is the responsibility of the flagger to control this situation and warn testers of the danger. Several flaggers may be used at the same time.

In the event that there are several manufacturers requiring flagging at the same time, multiple flaggers may be used. If multiple flaggers are used, each flagger shall be preceded by a Flagger Ahead Symbol five hundred feet (500) in advance.

The use of law enforcement is a highly recommended addition to this work plan. Usually this would be an off duty highway patrolman, but in some cases a local law enforcement officer may be an option. Regardless it is recommended that the individual filling this position be involved with the design of the traffic control plan and has a full understanding of the process. Work zone training may be necessary.

Example: TRAFFIC CONTROL PLAN

Notes - Assumed Roadway Speed of Sixty-Five (65 mph)

8. Advance Warning Signs
    a. Road Work Ahead
    b. Right Lane Closed Ahead
    c. Lane Drop
    d. Lane Shift
    e. Flagger Ahead Symbol – Placed 500 feet ahead of flagger – Each Flagger requires a Flagger Ahead Symbol
9. Transition Area Taper
    a. Merging Taper Length – 780 Feet
    b. Device Spacing – Maximum Spacing of 65 Feet, 13 Devices (Drums or Type II Barricades).
10. Buffer Space
    a. Buffer Length – Minimum of 500 Feet
    b. Device Placement – Field Side of Skip Line
    c. Device Spacing – Maximum Spacing 100 Feet
11. Shifting Taper (Five (5) Foot Shift)
    a. Shifting Taper Length – 260 Feet
    b. Device Spacing - Maximum Spacing of 65 Feet, 4 Devices (Drums or Type II Barricades).
12. Work Area
    a. Device Spacing – Forty (40) feet (Skip Line to Skip Line)
    b. Device Placement - Four (4) foot shift of traffic towards center median
        i. Edge of device four (4) feet towards Center Median
        ii. Additional devices placed just beyond outside edge of shoulder
13. Advance Warning Signing for Flaggers
    a. Sign Spacing – Five-hundred (500) feet in advance of each Flagger

12 Feet
16 Feet

500’
500’
2640’
1500’
1000’

SECTION SIX: TYPICAL DECK OPERATIONS

6.1 Typical Deck Operations

This section will cover a typical day on a work deck and will be a review of most of the information covered in section four, in a sequential manner. Problems such as wet weather and extreme heat will also be addressed.

6.2 Work Zone Setup

Traffic control can be handled by the test deck facilitators, Department of Transportation, or contracted to a Traffic Control Specialist. Unless the test deck facilitators are affiliated with the local Department of Transportation, they may not have the equipment or expertise to handle the traffic control. Furthermore, traffic control over the life of the test deck operation is expensive and carries associated liability. In addition, the setup and removal of the traffic control devices will add one (1) to two (2) hours per day that the test deck facilitators will be on the test deck site. For these reasons, if the test deck facilitator chooses not to handle the traffic control on their own, it is advisable that they let the Department of Transportation or AASHTO accept responsibility for the cost and coordination of the traffic control. Properly trained members of the test deck facilitation crew may handle the flagging of the operation.

Photo 39. Work Zone Setup

Whether or not the test deck facilitator or the contractor handles the traffic control, the operation should be set up one hour prior to the scheduled arrival of the first manufacturer. This will give the test deck facilitation crew time to review the outlined work for the day and to set up and to calibrate their equipment.

A manufacturer will not begin applying their product until the surface temperature is fifty (50) degrees or higher and the surface has been dry for twenty-four (24) hours. Therefore, the starting time for the first manufacturer will depend on existing climatic conditions.

6.3 Equipment Setup

Once the traffic control devices have been installed and a drive through of the work area has been performed the test deck facilitators may set up their work area. The vehicle used as an office for the pavement test deck is situated between the auto-no-track area and the first sub-deck on the shoulder of the roadway. It is important to maintain a clear path for manufactures' application equipment to pass from the sub deck area to the auto-no-track area. This station is responsible for the collection of the weather data, and usually houses the computers used in the completion of forms and data manipulation. Supplies for the pavement test deck facilitation crew are stored at this site. Equipment required includes:

- Power source (generator)
- Weather Station
  - Lap top dedicated to the weather station
- Lap tops for completion of forms, downloading data and other office work
- Personal supplies
  - Sun screen
  - Hard hats
  - Gloves
  - Water
  - Ice
  - First aid kit
  - Shade
  - Office supplies
  - Retroreflective vests

Next the weigh station houses may be set up. The weigh station houses are set up within the area of the sub deck locations where manufacturers will be applying their products that day.

Station houses are setup on the shoulder of the roadway, again providing a channel for manufacturer's application equipment to pass from the calibration area to their respective setup areas and the sub decks they will be applying their product on. Equipment required at each station house includes:

- Station house
- Power source (generator)
- Scale
- Calibration forms
- Thickness gauge
- Surface temperature gauge
- Sand bags
- Shims (for leveling station house)
- Clip boards
- Pens and pencils
- Lumber crayon for no-track and test line marking
- Tape measure
- Q panels (12" by 12") and (4" by 12")
- Calculator
- Utility box for storage of the above equipment

Having the facilitators' equipment setup and organized before the manufacturers arrive at the deck decreases congestion and improves the safety of the test deck operation.

6.4 Manufacturer Setup

When the manufacturer arrives on the test deck they will need guidance as to where they should park their equipment and upon which sub decks they will be making their product application. Each manufacture should be advised which test deck facilitator they will be working with while on the test deck site. This facilitator will have the responsibility of working with the respective manufacturer in the set up, calibration, protection (flagging), and application of their products.

Once the manufacturer has been assigned a work area they may set up their equipment. The manufacturer should use this area for unloading, setting up their initial equipment, and repairing equipment. After the manufacturers feel they have their equipment ready for product application, they should notify their test deck facilitator, who will work with them in the next step of the application process.

Photo 40. Paint Calibration

6.4.1 Paints

For manufacturers applying paint products, the next step in the process is the calibration of the application equipment. The calibration process is performed in the general area of a scale house. Each manufacturer will lay down roofing paper with sufficient anchoring to keep the paper from being blown away by passing vehicles or wind. Usually this is accomplished using duct tape on the perimeter of the roofing paper. Following preparation of the calibration site the manufacturer will be given a set of three 12” by 12” by 1/16” stainless steel panels. The manufacturer will use these panels in the calibration process and will be responsible for keeping them clean. The manufacturer will need to supply two wash buckets of water to clean and rinse the panels.

Calibration of the application equipment requires that the manufacturer make adjustments in their equipment to assure the settings will produce a marking based on their recommended application standards. This usually refers to the thickness of the line and the pounds per gallon of beads. In order to accurately calculate the thickness of the marking, the width of the marking is required. Present test deck procedures call for a four (4)-inch line; however, some manufacturers may wish to install six (6)-inch lines. Test deck facilitators should understand the equations used in the calculation of the line thickness so that they may make the proper substitutions when the line width varies. The first measurement is the weighing and **tare** of the unmarked test panel. The width of an unbeaded applied line is measured to conform to a 4” or

6” width as well weight related to proper thickness. The unbeaded line shall not exceed the maximum theoretical weight calculated previously. After it has been determined that the width and marking thickness meet the manufacturer’s standard, the process will be repeated with the inclusion of beads applied onto the line. Again the panel is weighed and the pounds per gallon of beads are calculated and compared with the manufacturer’s standards. Calibration is an iterative process that needs to be repeated as often as necessary to provide a marking that is as close to the manufacturer’s standards as possible. Repeated markings placed on the roofing paper tend to create a build up of paint that can foul the panel and affect the tare weight. Therefore, the manufacturer should clean paint spray from the panel that has either blown onto areas outside the line width or paint materials that foul the underside of the panel. It does not take much foreign matter to put the weight of the pavement marking outside of the standard parameters. Following the calibration of the manufacturer’s installation, equipment evaluation of the drying time of the paint is required.

Evaluation of the paint marking materials’ drying time is performed at the auto-no-track area of the pavement test deck. This area is generally the first work area of the pavement test deck site and is located in advance of any sub decks identified for application of marking materials. It is located far enough in advance of the anticipated work to allow a passenger car traveling at 15 mph to safely stop before entering subsequent work areas on the test deck. The manufacturer installs a marking at a 25-35 degree angle to the line of travel from the skip line to the edge line of the roadway. Installing the marking at an angle serves two purposes, first it represents the angle that a passenger car would make as it changes lanes and crosses the center line and second it allows the manufacture to better negotiate the turn from completion of the marking and movement to their assigned sub deck.

Photo 41. Auto No Track Area

The auto-no-track evaluation will require a flagman to stop traffic, a facilitator to check for tracking of the paint material, and two facilitators in a passenger car. In order for the manufacturer to mark from the skip line to the edge line of the roadway they must move out into the open traffic lane, line up their equipment, and apply the paint marking. During the time the manufacturer is moving into the open traffic lane and lining up their equipment, traffic will need to be controlled by a flagman. This will require that the flagman coordinate with the manufacturer to minimize delay to through traffic and afford safety for the manufacturer.

Prior to applying the marking, the manufacturer will indicate to their facilitator the minimum time they feel it will take for the paint material to dry. Usually this is measured in increments of thirty (30) seconds. For example suppose that a manufacturer indicates that they expect their product to dry in this minimum time. Thirty (30) seconds after the marking is applied a passenger car will be passed over the marking at a constant speed of fifteen (15) miles per hour. A facilitator will observe the path of the passenger car to ascertain whether or not the marking material was tracked by the wheels of the passenger car. This inspection will be performed from a position fifty (50) feet prior to the paint marking and in the direction the passenger vehicle is traveling. If the material is observed to have tracked, then the manufacturer may choose another time interval and the evaluation will be repeated. Once the no-track time has been determined the manufacturer may proceed to their assigned sub deck to begin the application of their product.

Photo 42. Failed Track Test

The first application on a sub deck takes place following the existing skip line. It cannot be guaranteed that that existing skip lines will not be renewed some time during the life of the test deck. Experience has shown that when skip lines are renewed the line may begin and end some distance before or after the existing marking. The test deck facilitator should anticipate this and instruct the manufacturer to make the first application approximately one foot beyond the existing skip line. Two markings are made side by side on two different sub decks with one sub deck between each pair of markings. The distance between the markings should be close enough to maximize the number of markings that can be applied on each deck but far enough apart that the marking being applied will not affect the previous line either from the equipment or from the blown marking material or beads. Before applying the marking material the manufacturer should place roofing shingles to cover the existing edge line and in line with the projected outside edge of the existing skip line to maintain an even longitudinal line between existing skip lines. While manufacturers make the marking from the edge line to the skip line, a flagman will be required to protect the manufacturer when he enters the skip line area. This will require two test deck facilitators, one to handle the flagging and one to receive a signal from the flagman when the manufacturer may proceed with the marking. Once the application process begins, the manufacturer will not be able to stop the equipment until the marking is complete. At this time the application equipment will be fouling the skip line area. The manufacturer will be intent on the application process and will be dependent on the test deck facilitators for protection. Test deck facilitators should perform checks on some installations to assure that the same mil thickness is being applied on the deck as was applied during calibration.

Once the markings have been installed the manufacturer will inspect the markings to determine whether or not they wish to accept that particular line for further evaluation or have the line marked out. If the manufacturer chooses to mark out the line they will apply another marking. Manufacturers shall decide whether or not to accept a marking before the close of the test deck on the day the marking is installed. Markings placed by manufactures should be numbered consecutively, either on the marking itself or outside the edge line adjacent to the marking.

Photo 43. Manufacturer Inspection

Each sub deck has two areas between skip lines for application of the markings. It is conceivable that two manufacturers will be working at the same time on the same sub deck. For this reason one manufacturer may be applying markings between the first and second skip lines of the sub deck and the other between the second and third skip lines. For this reason the numbering of the markings between the first two skip lines should begin with the number one (1). The numbering between the second and third skip lines should begin with a number representing the maximum number of lines that may be placed between the first and second skip line, such as the number forty-five (45). After the manufacturer has installed two pairs of acceptable markings, one pair of markings per deck, the process will be complete. All lines, including lines which have been determined to be unacceptable, shall be numbered for identification purposes

6.4.2 Epoxies and Other Fluid Markings

Installation of Epoxies and other fluid markings is identical to paint marking material with the exception of the auto-no-track and clean up. Rarely do other fluid markings dry fast enough to warrant an auto-no-track evaluation, however if requested by the manufacturer it should be performed. Clean up of panels used in the calibration process, as outlined in the paints section, is accomplished with the use of solvents rather than water when working with epoxies and other fluid marking materials. The reader should refer to the previous section referencing paint marking materials for details in the installation process.

6.4.3 Thermoplastics

Test deck facilitators' involvement in the installation of fluid thermoplastics is minimal. Two pairs of markings are required, one pair on two sub decks separated by one sub deck. This is to ensure that if one set of markings is destroyed one set will still remain for evaluation. Manufacturers begin the installation process by setting up an area close to the sub deck where they will be applying their product. Each manufacturer will be required to supply roofing paper, shingles, and duct tape. A section of roofing paper (10 – 15 feet) is required underneath the application equipment during setup, application testing, and sampling of the product. In order to determine the thickness of the marking, they will need to place a 4in X 8in. panel by less than 1/16 in. width on the roadway surface in the path of the marking installation on one of the four lines that will be installing. This panel should be anchored on the outside edges to the roadway surface with duct tape. In addition the manufacturer should place roofing shingles on both ends of the application area. Shingles on the edge line end of the marking should be set to protect the existing edge line marking. Shingles on the skip line side of the marking being installed should be set in line with the far side edge of the existing skip line. It is important that this line be maintained, and it is recommended that a chalk line be snapped to identify the location that the marking application is terminated. This is important because this is one of the areas that evaluation of the marking will be performed and the end of the marking must be accurate for consistency.

Note: Metal panels should not be used for measuring thickness of preformed thermoplastics (as they will give inaccurate results).

Setup of the application equipment is time intensive; therefore, one test deck facilitator can work with multiple manufacturers when applying fluid thermoplastics. Preparation of thermoplastics requires the manufacturer to heat a powder to high temperatures to form the liquid product. Once the manufacturer is confident that the material is sufficiently processed they are required to sample the material by collecting enough material into an aluminum-roasting pan to meet the fifty (50)-pound sample requirement for solids. At this time they will also make a short sample marking on the roofing paper to assure that their application equipment is working properly. Once they are satisfied that the product is ready for application and their equipment is working properly they may begin the installation process.

Actual installation of the marking requires the manufacturer to line up their equipment perpendicular to the roadway, and install the marking from the edge line to the far side of the skip lines. While installing the marking the manufacturer will be intent on the operation of the equipment and will rely on the test deck facilitator for protection when they are completing the marking in the skip line area. In order to properly "run out" the application of the line and maintain a uniform application, the manufacturer will not begin to shut the machine down until the marking is complete to the outer edge of the skip line area. Therefore, the test deck facilitator will need to stop oncoming traffic until the application of the marking is complete and the equipment is wheeled back into the work area.

Upon completion of the installation of the fluid thermoplastic markings and after the markings have been given time to cool, the test deck facilitator should collect the panel with the marking in tact and measure the thickness of the marking with a thickness gauge. Marking of the panel with the date and PMM number is recommended. The panel ought to be retained, at least until the manufacturer has completed their work on the test deck.

6.4.4 Durable Tapes & Pre Formed Thermoplastics

From the stand point of the test deck facilitators, the installation of durable tapes is straight forward. When the manufacturer arrives at the test deck they will need to be given the location of the sub decks identified for application of the particular type of product they will be applying. As with the paints/epoxies and thermoplastics, durable tapes & preformed thermoplastics are to

be installed in pairs on two sub decks with one sub deck in between. Preparation time before the manufacturer begins the installation of the marking is short. Once the manufacturer has unloaded their equipment and inspected the surface for installation they will be ready to begin. Manufacturers should notify the assigned test deck facilitator to observe the installation process. As noted earlier, manufacturers applying durable tapes and thermoplastic tapes may need to prepare the surface with solvents or may incorporate other special preparation for the surface. This should be noted on the installation sheet as well as the use of propane torches or other devices to warm the surface prior to application. If the manufacturer is applying pre formed thermoplastics they should be supplied a 4 X 6 X 1/16-inch panel that they will lay in the path of their installed marking. Again, the installation of the marking should run from the edge line to outside edge of the skip line. A chalk line should be used to mark a line between existing skip lines to assure the end of the marking.

Test deck facilitators should obtain samples of the tapes at this time. Information that needs to be collected includes preparation or treatment of the surface before application begins, heating of the surface, heating of the tape, and weighted rolling of the tape.

6.4.5 Removable Tapes

In order to insure that six months worth of data are collected for removable products they may be installed in the spring following the startup of a test deck. In most cases this will only pertain to test decks in the northern states that are susceptible to snow and ice that will prohibit winter evaluations.

Removable tape manufactures usually have little installation equipment and will typically work out of the back of a passenger car or small pickup. Installation of removable tapes calls for six (6) transverse lines on a single sub deck and three (3) pairs of longitudinal lines placed parallel to existing skip lines. Once the manufacturer has been advised of the locations to install their products the facilitators duties will involve collecting samples, observing installation and providing traffic control.

The six (6) longitudinal lines will be placed on a single sub deck with a distance of not less than two (3) inches between each of the markings. Each of the pairs of longitudinal markings will be placed parallel to existing skip lines. A distance of two (2) inches should be maintained between the existing skip line and each of the removable marking materials. Any preparation of the surface prior to the application of the marking material should be noted and samples of the marking material collected at this time. Surface shall not be released for traffic before a minimum of one hour has elapsed after the last application.

6.5 End of Day

Manufacturers are given the opportunity to withdraw a marking and schedule a reinstallation any time during the day of the initial installation. After that time the removal and reinstallation of markings shall be approved by the NTPEP PM committee on a case-by-case basis.

Test deck facilitators should notify manufacturers of scheduled test deck closing time. Based on this information, manufacturers should schedule the installation of their final product for the day so that the materials will be adequately cured for traffic prior to opening the test deck area. Once the manufacturers have completed their installation, facilitators should ensure that all markings have been numbered and that the test deck map has been updated with the products that have been installed. Test deck facilitators should then drive through the work zone to ensure that all manufacturers and equipment are clear of the roadway and shoulder before the release of traffic.

SECTION 7: MONTHLY AND QUARTERLY DATA COLLECTIONS

This section details the evaluation of pavement markings following installation. Quality checks are discussed to assure proper tracking of data.

Initial field performance tests shall be made within seven (7) days following installation of each marking, then approximately every thirty (30) days thereafter during the first year, and at intervals of approximately one hundred and twenty (120) days through subsequent years.

Table 111 Evaluation Intervals

Evaluation Intervals	
Initial Evaluations	7 days
First Year	30 days
Second Year	120 days
*Third Year	120 days

* Third year evaluation may not be authorized

While removable temporary pavement marking tape is evaluated on the same schedule as other pavement markings the initial installation may vary. In warm climates where it is possible to perform evaluations year round the temporary marking material should be installed at the same time as the other marking materials and evaluations performed on the same schedule. In regions where winter weather may hamper the evaluation of the markings installed on the test deck, installation of temporary marking material may need to be installed either before or after the start up of the deck to insure a six (6) month evaluation period.

7.1 Preparation

Set up of the work zone for evaluation of the marking materials is similar to the installation set up. Evaluations will be made in the skip line area as well as the left wheel path. Therefore flagman will be required to slow traffic and traffic control devices should be setup to move

traffic onto the inside shoulder to free up the skip line area. Working against the current of traffic may afford technicians a view of oncoming traffic and better protection.

Before beginning evaluation of markings placed on the deck it is important to create a spread sheet mapping out the test deck. The spread sheet should categorize the test deck by surface type, sub decks, line number, material type, and color as shown in Table 112.

Table 112 Test Deck Mapping

Asphalt				
Sub deck	Line Number	Material type	Color	PMM Number
1	1	Paint	Yellow	PMM-?????
	2	.	.	
	3	.	.	

Collection of data on the test deck is done with automated equipment capable of storing the data for the entire test deck. The equipment automatically assigns a unique number to the first reading and increments following readings consecutively. It is recommended that the technician operating the equipment note the beginning number of each sub deck on a scratch sheet to act as a marker for downloaded evaluation data. Once the data is collected it can be downloaded directly to either a text file or spread sheet. After downloading, the results can be pasted into the spread sheet mapping the test deck and inspected for accuracy. If all readings were taken correctly the data will line up with the mapping spread sheet. If there are extra readings or readings are missing it is easy to identify the problem area using the readings recorded by the technician at the beginning of each sub deck and the sub deck can be reevaluated if necessary. Additionally readings can be inspected for accuracy, for example, retroreflectivity readings for a black, removable tape will have a retro reading of five (5) or less, and color readings for any given colored marking will be within some range. Simply sort the data on the parameter in question and make a relative comparison of the results.

As the deck ages, prior to beginning the evaluations it is productive to refresh the onsite markings for each sub-deck, line, and rejected line mark out. This will aid the technician in identification of markings to be evaluated and improve the accuracy of evaluations performed.

7.2 Evaluations of Pavement Markings Materials

The following evaluations shall be performed on makings installed on a NTPEP Test deck at intervals outlined in Table 111.

- Retroreflectivity (night time visibility)
- Wet Night Retroreflectivity (as requested by manufacturer)
- Night Color (yellow markings only)
- Day Color
- Durability
- Photo Logging

Retroreflectivity, Durability and Photo Logging of evaluations shall be performed within eighteen (18) inches of the left wheel path (nine inches both sides of the location with the greatest wear) and the last nine (9) inches of the transverse line in the skip line area. Wet Night Retroreflectivity will only be evaluated in the left wheel path.

7.2.1 Retroreflectivity, Wet Night Retroreflectivity, Night Color Evaluation

Retroreflectivity readings are taken with a 30-meter CEN Geometry portable retroreflectometer in accordance with ASTM E 1710. Note that the Wet Night Retroreflectivity evaluation will only be performed at the request of the manufacturer of the material in accordance with ASTM E 2177.

Two retroreflectometers working in tandem will be required to perform the retroreflectivity evaluations. At the writing of this work plan Delta's LTL-X and their LTL 2000 Y developed with the aid of, and distributed by Flint Trading, represent the latest technology and are specified for use on NTPEP test decks. The **LTL-X** is capable of reliably measuring wet

markings for nighttime performance in accordance with the recently published ASTM E 2177 "Standard Condition of Wetness" as well as night time visibility.

Photo 44. Wetting Marking

Photo 45. Saturated Marking

Photo 46. Taking Reading

Photo 47. Taking Reading

The LTL 2000Y can determine the nighttime CIE color coordinates (x and y) of yellow pavement markings based on the 30-meter geometry as well as night time visibility. Nighttime color data collection (color materials) – is a measurement of the nighttime color under simulated driver conditions per 30-meter geometry per ASTM E 811. The LTL 2000Y does not provide daytime color measurements that are measured with a spectrophotometer. One each of the LTL-X and LTL 2000Y will be required. The intention is not to collect both retroreflectivity and either night time color or wet night retroreflectivity at the same time but rather to use equipment that can perform dual functions. Calibration of each of the reflectometers at the start of the day and at two (2) hour intervals throughout the day shall be performed. Retroreflectometers shall be maintained under the maintenance contract of the distributors and shall be returned for tune up at intervals specified by the manufacturer. Refer to appendix ??? for operating instructions for each of the above mentioned Retroreflectometers.

7.2.2 Daytime Color Evaluation

The color shall be determined by a color measuring instrumentation which provides coordinates in CIE color units which can be converted for use in both field and laboratory applications. All evaluations of yellow materials shall be compatible with and referenced to the CIE data provided by the PR-1 chart. This evaluation shall be performed in the un-beaded area of the test line to minimize the affect of dirt collection, mold growth, etc. Values which have exceeded the tolerance limits set by the PR-1 chart shall be noted. The determination shall be made without preliminary washing or other modification of the surface of the test lines. The reported data shall be evaluated by the use of ASTM E 178.

Daylight color readings are taken with a Gardner 6805 color guide spectrophotometer available from Fling Trading. Illuminant and Observation angles currently approved are a D65 illuminant and 2 degree observer which must be set before performing the evaluation. Night time color evaluations shall be taken with the LTL 2000Y at 30 degree geometry per ASTM E 811.

Use of the Gardner 6805 color guide for evaluation of daylight color is performed within the first three (3) feet, on the field side, of the transverse marking. Although the Gardner 6805 is designed to average multiple readings the technician is only required to take one reading per

line. The averaging of readings is performed for the total of four lines (per product) rather than for each line. This tool was not designed for this application and is a time consuming laborious effort requiring the operator to either kneel for each reading or scoot along with the use of knee pads evaluating each marking. At some locations test deck facilitators have been able to devise a device out of PC tubing which allows the operator to remain standing as the data is collected. Additionally when downloaded the evaluations the information is downloaded directly to an excel spread sheet, while this makes it convenient to manipulate the data it also increases the download time significantly. Depending on the type of lab top used for downloading this can up to thirty (30) minutes for four-hundred (400) data lines. During this time the operator needs to be careful not to interrupt the download, any jostling of either the color guide or the lap top may cause the download to terminate.

7.2.3 Photo Logging

Photo logging of the pavement markings involves photographing each pair of markings from the field side of the roadway toward the center of the roadway. One picture for each pair of markings is taken. It can be expected that the photographs will be viewed on a computer; therefore the quality of the picture being taken may be reduced to good quality (less than 100 KB). At this time the photograph taken is meant to capture the entire line and provides general information on the appearance and condition of the marking. It is anticipated that manufacturers will be able to use this information in evaluating the type of failures that may be occurring with their products and to identify field conditions that may not be apparent (dirt, dust or other debris on markings) from other evaluations. Consumers will be able to use this information to make relative comparisons and better understand the relationship between evaluations and the condition of the marking.

Facilitators currently using this procedure have been using a tripod to try and capture comparable heights and angles of photographs however this has not proven to be worth the trouble of packing a tripod down the roadway for each picture. Probably the picture can be taken free hand or with a monopod and still meet the requirements of the photo as outlined above.

7.2.4 Durability Evaluations

Durability evaluations shall be performed by three (3) trained evaluators who will separately rate the markings in both the wheel path and the skip line area on a scale of one (1) to ten (10). A rating of ten (10) will indicate that 100% of the marking remains in relation to the original installation. Results of their ratings will be averaged for a final score. There is a temptation to try and perform the durability analysis with one person, note that this is a subjective rating and it is doubtful that a single person can consistently evaluate the markings on a line by line basis or a visit by visit basis. Calibration photographs are provided in appendix ?? to aid in training the technicians eye.

7.3 Evaluation of Removable Temporary Pavement Marking Tapes

Removable temporary pavement marking evaluation periods lasts six months. After each of the six, thirty (30) day periods, each line will be evaluated on retroreflectivity, color (day and night), durability, and photo logging. At this time, one longitudinal line and one transverse line will be removed and "removeability" as well as "discernability" of markings left after line removal will be evaluated. If the temperature requirements for removal as specified by the manufacturer are exceeded, the lines shall not be removed until the temperature is within the specified limits. If it is necessary to postpone removal it shall be noted in the report.

7.3.1 Removeability

After each thirty (30) day period, one longitudinally installed line and one transverse line shall be removed from the pavement. Each line shall be rated on a scale of 0 to 10 in accordance with the following guidance:

10 - easily removable in on complete section

8 - Most of the material is easily removable – some breakage in wheel track. Removes in 3 to 4 pieces.

6 - Variable removeability with some large and some smaller pieces (6 to 8 pieces)

4 - Some what difficult to remove with many small pieces.

2 - Most of the material is difficult to remove with splitting or breaking into smaller pieces.

0 - Removable on in very small pieces. May require grinding.

7.3.2 Discernable Markings after Removal

A discernable marking is any marking, stain or discoloration that can be detected on the pavement surface under any light or weather condition after removal. Each line shall be evaluated thirty (30) days after removal and rated on a scale of zero (0) to ten (10). A ten (10) constitutes no discernible markings after the line is removed. A zero (0) is given when the entire line is discernable thirty (30) days after removal.

7.4 Time Requirements for Evaluations

Three (3) passes through each deck will be required to complete the evaluations. A conservative estimate of the time to compete the first pass is three (3) hours per 400 lines. This includes downloading the data to a lap top and a preliminary quality check whereby the results are pasted into the mapping spread sheet. The first pass through the deck will require a total of five (5) people, one (1) flagger, two (2) retroreflectometer operators, one (1) color guide operator, one (1) data manager, and (1) supervisor.

The second pass will also require six (6) people and the time to complete the pass will depend on the number of lines being evaluated for Wet Night Retroreflectivity. At this time the assumption is that this number will be minimal. Therefore the bottle neck in this pass will be the night color evaluations, which can realistically be equal to half the markings installed on the deck (yellow markings). The required time is estimated to be one and one half (1 1/2) to two (2) hours per four hundred lines. Tasks are one (1) photographer, two (2) reflectometer operators (Wet Night Retroreflectivity), one (1) LTL 2000Y operator (night color, yellow lines), one (1) data manager, and one (1) supervisor.

The third pass will also require six (6) people, one (1) flagger, three (3) technicians to perform the durability analysis, removeability, and discernability, one (1) data manager, and one (1)

supervisor. A flagman will be required to slow traffic while the technicians are evaluating the skip line area. The approximate time to complete this pass, for 400 lines, is two (2) hours.

Section 7: Reporting

Insert info on other reporting items:

(1) During application the air temperature, pavement temperature and humidity, shall be recorded hourly.
(2) The test deck State shall mention if studded tire and chain usage is allowed within the test deck.
(3) The test deck State shall report the type of treatment used for snow removal and the snow plow policy.
(4) The test deck State shall note the type of plow and plow blades and/or if shoes are being used during winter maintenance.

Insert Section on Data Mining

1 APPENDICES

Appendix 1

Temporary Tape					
Test type	**Location**	**Testing Increments**	**Comment**	**Lines**	
Retroreflectivity	Left wheel path and skip line	0 Then Monthly	All colors	All	Averaged
Daytime Color	Left wheel path	Months 0,1, 3, & 5	All colors	Just Line 5&6	Averaged
Nighttime Color	Left wheel path	Months 0,1, 3, & 5	Yellow only	Just Line 5&6	Averaged
Wet Retroreflectivity	Right edge line	1st test - 30 days and then every month	Test method ASTM 2177 Recovery using a sprayer to wet the area. Both colors to be tested.	Just Line 3,4,5&6	Averaged
Photo Log	Entire Line/All Lines	Monthly			
Longitudinal lines - 6 feet					
Note: Yellow lines will typically be parallel to the skip lines and the white lines may be place in between the skips					
The following measurements will be taking on only half of the temporary tapes that are on the deck the longest.					
Retroreflectivity	Mid-point of line	0, Monthy	All Colors	All	Averaged
Daytime Color	Mid-point of line	Months 0,1, 3, & 5	All Colors	Just Line 5&6	Averaged
Nighttime Color	Mid-point of line	Months 0,1, 3, & 5	Yellow only	Just Line 5&6	Averaged
Wet Retroreflectivity	Mid-point of line	1st test - 30 days and then every month	Test method ASTM 2177 Recovery test using a sprayer to wet the area. Both colors to be tested.	Just Line 3,4,5&6	Averaged
Photo Log	Entire Line/All Lines	Monthly			

Appendix 2

Permanent Markings			
Test type	**Location**	**Testing Increments**	**Comment**
Retroreflectivity	Left wheel path and skip line	First year monthy Second and third year quarterly mesurements	All colors
Durability	Left wheel path and skip line	First year monthy Second and third year quarterly mesurements	All colors
Daytime Color	Skip line	First year months 0, 6, & 12 Second and third year 6 & 12 month (pre & post winter for northern test decks)	All colors
Nighttime Color	Skip line	First year months 0, 6, & 12 Second and third year 6 & 12 month (pre & post winter for northern test decks)	Yellow only
Wet Retroreflectivity	Both sides of the right wheel path	Quarterly testing for all three years	Test method ASTM 2177 Recovery test using a sprayer to wet the area. Both colors to be tested.
Photo Log	Entire Line	Quarterly	

1