CHAPTER ONE

INTRODUCTION

Pavement markings are an important means of communicating information to drivers. There are many differences in pavement marking practices among state and local transportation agencies in the United States and Canada, however, because of variations in their structure, policies, and climate. Because of changes in technology, driver needs, and environmental constraints more materials are being evaluated and used than in the past. New technologies and methods for measuring the performance of pavement markings have been and continue to be developed, increasing the breadth and scope of this topic area.

In its *Transportation Glossary* (1983), AASHTO defines pavement/traffic markings as "All lines, patterns, words, colors, or other devices, except signs, set into the surface of, applied upon, or attached to the pavement or curbing or to the objects within or adjacent to the roadway, officially placed for the purpose of regulating, warning, or guiding traffic."In Part 3 of the *Manual On Uniform Traffic Control Devices* (MUTCD), the FHWA presents the basic principles that govern the design and use of traffic-control devices for all streets and highways open to public travel regardless of type, class, or the public agency having jurisdiction [*MUTCD 2000* (2000)]. Types of pavement markings include longitudinal markings (centerline, lane line, edge line, and pavement marker) and transverse markings (shoulder, word and symbol, stop, yield, crosswalk, speed measurement, and parking space), which are defined in Part 1 of the MUTCD.

OBJECTIVES AND SCOPE

The objective of the synthesis is to document long-term pavement marking practices and research in the United States and Canada. Pavement marking practices are the usual ways a transportation agency selects, specifies, applies, maintains, and removes pavement markings. Best practices and new technology for managing pavement marking systems are described. Temporary pavement marking practices in work zones are *not* addressed.

Surveys were mailed to state transportation agencies, Canadian provinces and territories, counties, cities, and equipment/material manufacturers/distributors. Three types of surveys were sent: transportation agency, pavement marking equipment/material manufacturer/distributor, and retroreflectometer manufacturer/distributor. Appendix B cites the types and number of survey respondents.

At the time the survey respondents received the survey, the 1988 edition of the MUTCD was the guiding document (*Manual on Uniform Traffic* . . . 1988). Since then, the Millennium Edition of the MUTCD has been published. [*MUTCD 2000* (2000)].

BACKGROUND

A 1973 synthesis of pavement marking practices showed that transportation agencies were interested in identifying more durable and less expensive materials (Bollen 1973). In addition, agencies were concerned about increased traffic volumes causing rapid wear, daytime appearance, nighttime visibility on dry and wet pavements, and increased production while providing quality pavement markings.

In 1973, there was 6.1 million centerline-km (3.8 million centerline-mi) on the U.S. highway system. In 2000, there was more than 6.3 million centerline-km (3.9 million centerline-mi) on the U.S. highway system, an increase of almost 161,000 km (100,000 mi) [*Highway Statistics 2000* (2001)]. The increase in mileage, traffic, cost of materials, and regulations makes it more difficult for transportation agencies to maintain a quality system of pavement markings.

Problems and Challenges

Even though pavement-marking technology has greatly improved, the problems that needed solutions in 1973 are also concerns today. Transportation agencies and private companies that manufacture or supply pavement markings and equipment were surveyed in 2000 and identified the following problems and challenges they faced in providing quality pavement markings:

- Funding for pavement marking programs,
- Nighttime visibility in rain and fog,
- Quality control when markings are installed,
- Labor shortage,
- Improved performance in snow removal areas,
- Meeting the proposed standard for minimum levels of retroreflectivity,
- Managing the system of pavement markings,
- Environmental regulations, and
- Product acceptance and approval.

Funding

The problem cited most frequently by agencies was their budget and finding the necessary funding for pavement markings. Agencies are looking for better low-cost markings. The newer, more durable, pavement-marking materials cost more than waterborne paint, but the longer service lives of such materials make them cost-competitive. The funding shortage also creates a problem for the pavement marking industry. Purchasing materials and awarding contracts based only on the lowest bid, without regard to qualifications and experience, is believed to inhibit improved performance of pavement markings.

Nighttime Visibility

Increasing the retroreflectivity of markings during nighttime in rain and fog is a major challenge. Research showed that pavement markings reduced crashes at night on dry pavement, but not at night on wet pavement. Pavement markings must be applied according to specifications using standard procedures to achieve a long service life. The pavement marking industry is developing materials to provide improved retroreflectivity and service life.

Quality Control

Quality control and inspection procedures are used to ensure that markings are properly installed. Both agencies and industry believe that inadequate quality control and inspection is a major problem. Variations in specifications and quality-control procedures exist among agencies. Private companies also believe that inconsistent use and enforcement of specifications is a problem. Both believe that nighttime visibility can be increased through improved quality-control and inspection programs. More agencies are now using performance-based and warranty contracts that require contractors to be responsible for application, inspection, and performance for the life of the material.

Labor Shortage

Transportation agencies cited problems in retaining the staff needed to maintain a marking program, including engineers, inspectors, and striping crew personnel. Some agencies are alleviating the staff shortage problem by having more striping done under contract and less by agency personnel. However, private companies are also having trouble finding qualified workers because of a tight labor market.

Improved Performance in Snow Removal Areas

Snow removal is a major concern in many areas of the United States and Canada. Pavement markings can be damaged during snow removal. Being able to maintain markings in snow removal areas presents a major challenge and agencies in areas with snow and cold weather are looking for materials with improved performance.

Meeting Retroreflectivity Standards

The FHWA has developed candidate MUTCD criteria for retroreflectivity of pavement markings, but no such criteria have yet been approved and implemented as policy. Research results were used to develop draft guidelines for retroreflectivity based on type of roadway, speed limit, color of line, presence of roadway lighting, and presence of retroreflective raised pavement markings (RRPMs) (Turner 1998; Migletz et al. 2000). The guideline values were discussed at public meetings (Hawkins et al. 2000). Survey results showed that state and local transportation agencies believe that meeting a national standard based on the FHWA draft guidelines will be a major challenge (Hawkins et al. 2000).

Inventory Management System

An inventory management system tracks the service life of pavement markings and is also used as a budgeting tool. Some agencies have a working system, although for others developing a system is one of their major challenges. An inventory management system will improve service life and help agencies meet standards for pavement-marking retroreflectivity, which should lead to reductions in vehicle crashes.

Environmental Regulations

A U.S. Environmental Protection Agency (EPA) regulation significantly reduces the allowable volatile organic compound (VOC) of pavement markings (Cirillo et al. 1994). Meeting environmental restrictions is a major challenge for agencies wanting to use conventional solvent paint. Many agencies have switched from conventional solvent paint to waterborne paint, which is now available at a comparable price and provides a comparable service life. There is also concern about the slow drying time of waterborne paint.

Product Acceptance and Approval

Pavement marking companies expressed concern about the slow process for getting products approved for use on agency roads. The approval process often requires that new materials be evaluated at test sites under agency jurisdiction. Private companies are interested in a more universal acceptance of test results, where the results of tests done

for one agency would be accepted by other agencies. The Kansas Department of Transportation (KDOT) addresses universal acceptance in a special provision. Field evaluation may be waived if a complete field test was performed on the identical product by another state transportation agency or at the AASHTO test facility under the National Transportation Product Evaluation Program (NTPEP). Evaluation includes both hot and cold weather conditions for a minimum duration of 6 months (*Durable Pavement Marking* . . . 1990). A copy of the official test report and evidence that the product is identical to that submitted for prequalification is sent to the Engineer of Tests for approval.

Although better technology and longer-lasting materials are in use today, the safety and traffic demands, including disruption to traffic during application, on the system of streets and highways requires a continuing effort to address the problems and challenges.

Pavement-Marking Expenditure and Highway Mileage

Surveyed transportation agencies provided estimates of the total overall expenditure for obtaining, placing, and repairing pavement markings on the agency system of roads. The centerline mileage of highways was provided along with the respective mileages of highways with asphaltic concrete (AC) and portland cement concrete (PCC) pavement surfaces. Appendix C presents the breakdown of annual expenditure, centerline mileage, expenditure by centerline mileage, and mileage by pavement type for all agencies that responded to the survey. The estimated total spent on pavement markings in the year 2000 by the 50 state transportation agencies, 13 Canadian provinces and territories, U.S. counties, and U.S. cities was more than $1.5 billion on over 6.1 million centerline-km (3.8 million centerline-mi) of highways. Appendix C shows that state transportation agencies spend more per centerline-mile for pavement markings than the other agencies because they are responsible for more freeways and other multiple-lane facilities and use a greater variety of the more expensive durable materials and pavement markers.

Transportation agencies are restriping more often to maintain a higher level of retroreflectivity over a longer period of time, retroreflectometer usage is increasing, and more highly skilled workers are needed to place, maintain, and evaluate pavement markings. As a result of using new materials and technology, transportation agencies are spending more money to maintain their pavement-marking systems.

REPORT ORGANIZATION

In the following chapters, information relating to research and practice are presented. Examples of good practices are highlighted and gaps in knowledge are identified. Chapter 2 describes how agencies decide where to put pavement markings, how markings are selected, and when markings are removed or replaced. Chapter 3 presents information needed by drivers, including the preview time needed, amount of retroreflectivity needed, guidelines for minimum levels of retroreflectivity, cost needed to meet minimum levels of retroreflectivity, retroreflectivity of markings on wet pavements, and word and symbol markings that provide additional information to drivers. Chapter 4 describes the types of traffic crashes that can be reduced by pavement markings and the results of research evaluating the safety benefits of pavement markings. Chapter 5 discusses criteria for selecting materials for pavement markings. Chapter 6 reviews the types of specifications and construction practices used to provide quality pavement markings. Chapter 7 describes pavement-marking materials used by transportation agencies, service life, cost of materials, life-cycle cost of materials, and new materials that have the potential to improve service life. Chapter 8 presents information on a pavement-marking inventory management system used to track the life of a marking. Chapter 9 discusses practices for evaluating the performance of pavement markings. Subjective evaluations and objective evaluations using retroreflectometers are described. Correlations of retroreflective measurements using hand-held and mobile retroreflectometers are also described. Chapter 10 presents conclusions of the synthesis.

Appendix A provides the questionnaire used to survey transportation agencies and companies in the pavement marking industry. Appendix B cites the types and number of survey respondents. Appendix C presents the breakdown of pavement-marking expenditure and highway mileage in 2000. Appendix D shows examples of pavement-marking material selection guidelines used by state transportation agencies. Appendix E shows an example of a prescriptive/material special provision for epoxy, Appendix F an example of a performance-based special provision for waterborne paint, Appendix G an example of warranty provisions special provision for durable marking materials, Appendix H example glass bead specifications, Appendix I an example specification for raised pavement markers, and Appendix J an example test method for quality-control testing of pavement markings at the time of installation.

CHAPTER TWO

PROCESS FOR MAKING DECISIONS ON PAVEMENT MARKINGS

This chapter describes how transportation agencies decide where to place pavement markings, select marking materials, and decide when to remove or replace markings. Warrants for use of centerlines, lane lines, and edge lines are presented in Part 3 of the MUTCD and summarized here [*MUTCD 2000* (2000)]. All markings in the United States are required to conform to the MUTCD. Some agencies are known to exceed the MUTCD requirements.

DECIDING WHERE TO PUT PAVEMENT MARKINGS

Part 3 of the MUTCD presents general aspects of pavement markings including pavement and curb markings, object markers, delineators, colored pavement, barricades and channelizing devices, and islands. The decision on where to place longitudinal markings is summarized in Table 1 for centerlines, lane lines, and edge lines on paved streets and highways [*MUTCD 2000* (2000)]. For each type and color of line, the MUTCD presents the standards in large, bold type; guidance in large, but not bold type; and options in small type. Standards shall be satisfied, guidance should be followed, and options may be applicable for particular situations. Other types of markings are also addressed in Part 3.

Standard Colors

- Yellow lines delineate
  - The separation of traffic traveling in opposite directions,
  - The left edge of the roadways of divided and one-way highways and ramps, and
  - The separation of two-way, left-turn lanes and reversible lanes from other lanes.
- White lines delineate
  - The separation of traffic flows in the same direction, and
  - The right edge of the roadway.
- Red markings delineate roadways that shall not be entered or used.
- Blue markings delineate parking spaces for persons with disabilities.

Agency Policy and Practice

The policies of state transportation agencies address the MUTCD requirements for deciding where to put pavement markings. The majority of agencies use the MUTCD, agency policies, standard plans, and specifications. For a few agencies, engineering decisions determined where markings were placed.

Figure 1 presents the Georgia DOT pavement marking policy as a representative example of many state agencies ("Pavement Markings" 1996). The department uses thermoplastic and waterborne paint as the primary longitudinal marking materials. The road types and levels of average daily traffic (ADT) where the materials are used are described. For example, multilane highways with four or more lanes and Interstate highways receive thermoplastic. Two- and three-lane rural routes with an ADT of less than 10,000 receive waterborne paint. Raised pavement markers (RPMs) are placed on state and Interstate highways according to current standards. Day and night inspections of markings are done twice each year.

Five U.S. agencies gave the traveled way width criteria for marking centerlines or edge lines. For example, the Texas DOT places centerlines on roadways of 4.9 m (16 ft) or greater in width, and edge lines on traveled ways of 6.1 m (20 ft) and greater. The Virginia DOT (VDOT) pavement marking policy requires that centerlines be placed on primary and secondary hard-surfaced routes with a minimum traveled width of 5.5 m (18 ft) and an ADT of 500 veh/day ("Pavement Marking Policy" 1994). Edge lines are placed on routes with a traveled width of 6.1 m (20 ft) that have been centerlined and do not have a curb or gutter.

One province reported that all roads with a 900 or greater annual average daily traffic (AADT) were striped every year. Roads with 500 to 900 AADT were striped biannually and roads with 250 to 500 AADT were striped every third year, or when funding permitted.

SELECTING PAVEMENT-MARKING MATERIALS

Agencies were asked how they select materials (marking materials, glass beads, RPMs, etc.) for long-term pavement markings on the agency system of roads. One-third of the respondents (17) reported that agency policy or material specifications guided the selection. Several agencies stated that they used a specific material as their primary marking material. The most common materials mentioned were paint, epoxy (northeastern United States), and thermoplastic. Five agencies use judgment and experience to select materials.

TABLE 1
MUTCD WARRANTS FOR USE OF CENTERLINES, LANE LINES, AND EDGE LINES ON PAVED STREETS AND HIGHWAYS

Type of Line	Standard Color of Line	Standard (Shall) Guidance (Should) Option (May)	Type of Street and Highway	Traveled Width	Traffic Volume (ADT)	MUTCD Section
Centerline	Yellow	**Standard**	**Urban arterials and collectors**	**6.1 m (20 ft) or more**	**6,000 or greater**	**3B.01**
		Standard	**Two-way with three or more lanes**			**3B.01**
		Guidance	Urban arterials and collectors	6.1 m (20 ft) or more	4,000 or greater	3B.01
		Guidance	Rural arterials and collectors	5.5 m (18 ft)	3,000 or greater	3B.01
		Guidance	Others where an engineering study indicates a need			3B.01
		Guidance	Others where engineering judgment should be used in determining whether to place centerlines because of the potential for traffic encroaching on the pavement edges, traffic being affected by parked vehicles, and traffic encroaching into the opposing traffic lane	Less than 4.9 m (16 ft)		3B.01
		Option	*Other two-way traveled ways*	*4.9 m (16 ft) or more*		*3B.01*
Lane line	White	**Standard**	**Freeways and Interstate highways**			**3B.04**
		Guidance	Roadways with two or more adjacent traffic lanes having the same direction of travel			3B.04
		Guidance	Congested locations where roadway will accommodate more traffic with lane lines than without them			3B.04
Edge line	Yellow (left) and White (right)	**Standard**	**Freeways and expressways**			**3B.07**
		Standard	**Rural arterials**	**6.1 m (20 ft) or more**	**6,000 or greater**	**3B.07**
		Guidance	Rural arterials and collectors	6.1 m (20 ft) or more	3,000 or greater	3B.07
		Guidance	Others where an engineering study indicates a need for edge lines			3B.07
		Guidance	Should not be placed where an engineering study or engineering judgment indicates that providing them would decrease safety			3B.07
		Option	*Streets and highways that do not have centerline markings*			*3B.07*
		Option	*May be excluded, based on engineering judgment for reasons such as if the traveled way edges are delineated by curbs, parking, bicycle lanes, or other markings*			*3B.07*
		Option	*Where edge delineation is desirable to minimize unnecessary driving on paved shoulders or on refuge areas that have lesser structural pavement strength than the adjacent roadway*			*3B.07*

Notes: This table summarizes information and does not intend to interpret the MUTCD. The appropriate section of the MUTCD should be reviewed to get the exact wording of standards, guidance, and options. ADT = average daily traffic (veh/day).
(*Source*: *MUTCD 2000*, Part 3.)

6146-2

Pavement Markings

Document last updated 14-May-1996

It is the policy of the Georgia Department of Transportation to place and maintain pavement markings on the State Highway and Interstate Highway System of Georgia in accordance with the Manual of Uniform Traffic Control Devices.

Thermoplastic markings (including centerline, lane lines, edgelines and symbols) will generally be used on:

1. all multilane highways with a standard typical section of four or more lanes;
2. all interstate highways;
3. state highways with traffic volumes in excess of 10,000 ADT; and
4. other routes as designated by the State Maintenance Engineer.

Paint markings (including centerline, lane lines, edge lines and symbols) will be placed on state routes for which Thermoplastic does not qualify. This shall normally include:

1. two lane and three lane rural routes with less than 10,000 ADT; and
2. other routes as designated by the State Maintenance Engineer.

Raised pavement markers will be placed on all State Highways and the Interstate System in accordance with the current Georgia standards and/or construction details.

The condition of all pavement markings on the entire State Highway and interstate Highway System will be reviewed a minimum of twice annually during the semi-annual roadway inspections (one daytime and one nighttime) conducted through each District Maintenance Engineer's Office. Corrective measures and replacement will be accomplished as needs are identified and reported.

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FIGURE 1 Georgia Department of Transportation policy to meet MUTCD requirements for placing and maintaining pavement markings. (*Source*: GADOT 1996.)

Factors Used to Select and Decide Where to Put Pavement Markings

A number of state agencies use the following factors to select and decide where to put markings. (More detailed information on selecting marking materials is presented in chapter 5.)

- Width of traveled way;
- Traffic volumes;
- Pavement type;
- Pavement age, service life, or future reconstruction;
- Type of street and highway;
- Pavement condition;
- Bridges—PCC;
- Snow removal areas; and
- Brightness benefit factor.

The factors are common to many agencies, except for the last one. The brightness benefit factor was developed by KDOT and represents the combined effects of retroreflectivity, durability, and installation costs, including road-user costs.

National Transportation Product Evaluation Program (NTPEP)

The NTPEP was established in 1994 as a pooled-fund engineering, technical service program operated by AASHTO (NTPEP 2001; M.A. Basha, personal communication, October 5, 2001). State agencies in the AASHTO regions conduct testing of commercially available, proprietary engineered products for developing qualified products lists, which are used for product selection by state and local agencies and contractors. Other state agencies, such as the Texas DOT, perform much of their own research.

Laboratory testing has been done by four state agencies using various ASTM test methods. Field performance testing of transverse lines on test decks has been done by 10 state agencies using ASTM test method D 713-90 (reapproved in 1998) (*Standard Practice* . . . 1998). Ten types of products, including marking materials, regular and snowplowable RPMs, and RPM adhesive are evaluated.

State agencies use NTPEP as a means to screen commercially available products. Individually, they would not

be able to conduct testing at the level of rigor and/or sophistication as NTPEP. Industry submits their products for prequalification, which is required by most government agencies. For a fee, industry obtains the field performance history and/or laboratory test results on their products, alongside their competitors.

State Agency Survey Results

A survey of state transportation agencies was done to determine state reliance on NTPEP results and attitudes toward the NTPEP program (NTPEP 2001). Responses were received from 39 of 52 (75%) state agencies.

Many state agencies continue to conduct duplicate and different in-state testing of products instead of relying exclusively on NTPEP results. Reasons for conducting in-state testing include

- State-level policies or mandates that require in-state testing,
- Additional or different state specifications,
- A need for testing that addresses state-level traffic volume or climate concerns, and
- Concern about poor clarity or ease of use of NTPEP results.

Two-thirds (68%) of the state respondents perceive that NTPEP saves time and money by reducing the need for in-state testing. A majority (57%) intends to make greater use of NTPEP in the future by making more pavement-marking product approvals based primarily on NTPEP results.

Industry Survey Results

A survey of American Traffic Safety Service Association member safety product manufacturers was done because industry participation is critical to the success of NTPEP (NTPEP 2001). Responses were received from eight of 21 manufacturers (38%) covering the range of pavement-marking products evaluated by NTPEP.

Industry concerns about NTPEP are listed here, in order, from most to least important.

- Adequacy of testing procedures,
- Limited number of states that use NTPEP results,
- Consistency of testing (from year to year),
- Time required for NTPEP testing,
- High cost of testing fees,
- States that require both NTPEP and state tests, and
- Cost of other expenditures associated with NTPEP testing.

NTPEP Summary

Evidence from the surveys presents a somewhat contradictory picture of NTPEP. State agencies reported that the use of NTPEP results exclusively ranged from 24 to 36%. Industry respondents believed that the percentage of states that use NTPEP results exclusively in place of in-state testing ranged from 0 to 20%. Industry also believes that 61 to 80% of states do not use NTPEP data for approving products.

States voice strong support for the concept of the program and a majority indicated that they plan to rely more on NTPEP in the future. Six of eight industry respondents (75%) did not support an increase in the use of NTPEP. The cost of the NTPEP evaluation is a concern to the industry respondents. In addition to paying test fees, an average of 460 person-hours is spent annually on NTPEP-related testing.

Recommendations were developed to increase the strengths of the NTPEP program and include the following:

- Agree on a definition of success for the NTPEP program. At present there is no uniform concept of what constitutes success among states and industry.
- Develop and focus on priority product categories most suited to national performance-based testing and for which states have the greatest need for testing assistance.
- Work to overcome barriers to greater use of NTPEP results in states. The greatest barriers are state procedures that require testing that is either different from or a duplicate of NTPEP testing.
- Strengthen NTPEP's base throughout the United States. States' reliance on NTPEP is concentrated in the Southeastern Association of State Highway and Transportation Officials (SASHTO) region, but sporadic elsewhere. Lessons learned by SASHTO states can help other states increase participation.
- Improve NTPEP data clarity and timeliness, because results are often difficult to interpret. Clear presentation, use of graphics, digital formats, and user guides should be considered.
- Incorporate flexibility into NTPEP. The number of new products is increasing and product testing is changing. Impacts of changes should be assessed. NTPEP should be flexible to respond to changes as they occur.

DECIDING WHEN TO REMOVE OR REPLACE PAVEMENT MARKINGS

Most respondents answered the question, "How do you decide when to remove or replace pavement markings?" by discussing how they decide when to *replace* markings. The two main categories of answers were (1) that markings

were chosen for replacement based on field inspection or judgment of maintenance personnel and (2) that markings were replaced on a regular schedule. Agencies that did not use durable markings were more likely to replace markings on a regular schedule. Some of these same agencies only removed pavement markings in work zones.

Twenty agencies (39%) rely on the judgment of inspectors to decide when to replace markings. Both day and night inspections are conducted, and some agencies also measure retroreflectivity to decide when to replace markings.

Ten agencies (20%) replace markings on a regular basis. Most of these agencies use paint and therefore repaint every year. Agencies replace durable markings at longer intervals. For example, epoxy is replaced every 3 years.

Six agencies (12%) remove durable markings when they are to be replaced. One would remove epoxy if there were adhesion problems with the original markings.

Many agencies do not have experience in removing old markings. Three agencies (6%) never remove markings. Four agencies (8%) only removed them when traffic patterns changed during construction.

Other agencies are using retroreflectometers, both handheld and mobile, to evaluate retroreflectivity and develop pavement-marking inventory management systems. Specifications addressing the retroreflectivity of both new and existing markings are being used to monitor the work of striping contractors and to determine when to replace worn markings.

KDOT determines that a marking should be replaced based on the level of retroreflectivity, durability, and color performance ("Pavement Marking Policy . . ." 2000). Markings are replaced when

- There is a loss of retroreflectivity such that its average reading on a Mirolux 12 retroreflectometer or other approved retroreflectometer falls below 150 mcd/m^2/lux for white and 100 mcd/m^2/lux for yellow, or
- They become detached from the roadway because of adhesive failure, or
- They suffer a loss of pigment so that it no longer provides effective daytime lane delineation.

Agencies are looking to the FHWA for guidance to determine the appropriate level of retroreflectivity needed by nighttime drivers to determine when to remove worn markings.

SUMMARY

The MUTCD is the primary source of information on pavement markings in the United States [*MUTCD 2000* (2000)]. The MUTCD specifies and recommends where centerline, lane line, and edge line markings are to be provided based on the type of roadway, the width of traveled way, and ADT. Some agencies exceed the recommendations of the MUTCD.

Transportation agency policy and specifications guide material selection, application, and evaluation. Results of research on pavement-marking material color, retroreflectivity, and durability are used to improve marking programs. A number of state agencies use a variety of factors to select and decide where to put markings. Some agencies use the results of NTPEP evaluations to select materials, whereas others perform their own research.

Policies specify how and when pavement markings are replaced. Markings are replaced by some agencies based on regular field inspections and by others on a regular schedule. Field inspections are used to evaluate retroreflectivity, durability, and color performance to determine whether markings should be replaced. The use of retroreflectometers to evaluate initial and maintained retroreflectivity is increasing.