

*FHWA Pavement Design Policy
Listening Session, Peer Exchanges, and
National Workshop Summary Report*

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U.S. Department of Transportation
Federal Highway Administration

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Background

The Federal Highway Administration (FHWA), in response to correspondence from industry, was looking for feedback on FHWA's Pavement Design Policy and Guidance as represented in the following documents: Code of Federal Regulations, Title 23, Part 626; the Federal-aid Policy Guide Non-Regulatory Supplement NS 23 CFR part 626 *Pavement Design Considerations*, dated April 8, 1999; and Technical Advisory T5040.39A, *Use of Alternate Bidding for Pavement Type Selection*, dated December 20, 2012. Section 626.3, [Title 23 CFR](#) states: "Policy. Pavements shall be designed to accommodate current and predicted traffic needs in a safe, durable, and cost-effective manner." Regulations do not specify procedures to follow to meet the requirement. Instead, each State highway agency is expected to use a design procedure appropriate for its conditions.

As part of the feedback process, FHWA hosted a formal industry listening session in December 2018 to hear industry concerns regarding its Pavement Design Policy and Guidance. Between March 2019 and July 2019, FHWA also hosted five regional peer exchanges across the U.S. to hear from State Department of Transportation (DOT) representatives and FHWA Division Office representatives. As a follow up to these meetings, in October 2019, FHWA hosted a national summary workshop, which included participants representing industry, State DOTs, FHWA Division Offices, and other stakeholders. This report provides a summary of the industry listening session, the five regional peer exchanges, and the national workshop.

Meetings

The industry listening session was held December 14, 2018, at the FHWA headquarters in Washington, DC. The session was attended by 10 discussion participants representing 7 industry associations and consultants who provided input to the FHWA. These included American Concrete Pavement Association (ACPA), Advanced Concrete Pavement Consultancy LLC (ACPC), American Council of Engineering Companies (ACEC), Interlocking Concrete Pavement Institute (ICPI), National Asphalt Pavement Association (NAPA), National Ready Mixed Concrete Association (NRMCA), and National Stone, Sand, and Gravel Association (NSSGA). One additional individual from Fugro USA Land, Inc. provided input to the FHWA via email communication. Also in attendance at the session were individuals who did not provide any input, but participated only in a listening, moderating, or note-taking role. These included several Federal agency personnel from the FHWA and the Federal Aviation Administration (FAA), FHWA consultants that included the moderator and two note-takers, and one representative from American Association of State Highway and Transportation Officials (AASHTO).

Following the industry listening session, FHWA hosted five peer exchanges in which DOT representatives and FHWA Division Office representatives were provided the opportunity to discuss and document good practices and barriers to designing cost-effective pavements. During these peer exchanges, participants were also provided a summary from the industry listening session followed by a moderated discussion on the Pavement Design Policy and Guidance. 48 of the 52 States/District/Territory (including District of Columbia and Puerto Rico) were represented at the peer exchanges (Figure 1).

The southeast peer exchange took place at the Sam Nunn Federal Center in Atlanta, GA, on March 14–15, 2019. Attendees included staff from DOTs and FHWA Division Offices in Alabama, Arkansas, Florida, Georgia, Mississippi, North Carolina, Puerto Rico, South Carolina, Tennessee, Virginia, and West Virginia. The northeast peer exchange took place at the Maryland State Highway Administration in Hanover, MD,

on April 24–25, 2019. Attendees included staff from DOTs and FHWA Division Offices in Connecticut, Delaware, Maine, Maryland, New Jersey, New York, North Carolina, Pennsylvania, Rhode Island, Vermont, and the District of Columbia. The southwest peer exchange took place at FHWA’s office in Lakewood, CO, on May 21–22, 2019. Attendees included staff from DOTs and FHWA Division Offices in Arizona, Colorado, Louisiana, Nevada, New Mexico, North Dakota, South Dakota, Texas, Utah, and Wyoming. The northwest peer exchange took place in Portland, OR, on June 13–14, 2019. Attendees included representatives from DOTs and FHWA Division Offices in Alaska, California, Idaho, Kansas, Montana, Nebraska, Oklahoma, Oregon, and Washington. The midwest peer exchange took place in Minneapolis, MN, on July 18–19, 2019. Attendees included representatives from DOTs and FHWA Division Offices in Illinois, Indiana, Iowa, Kentucky, Michigan, Minnesota, Missouri, Ohio, and Wisconsin.

The national summary workshop was held on October 24, 2019, at FHWA Headquarters in Washington, DC. Three representatives consisting of two representatives from State DOTs and one from FHWA Division Office from each regional peer exchange attended the workshop. Industry was represented by members from the ACPA, ACPC, Applied Pavement Technology, NAPA, NSSGA, and APWA. As in the case of the listening session, also in attendance at the workshop were individuals who did not provide any input, but participated only in a listening, moderating, or note-taking role. These included several Federal agency personnel and FHWA consultants that included two moderators and a note-taker. The purpose of the workshop was to summarize the findings from the industry listening session and the peer exchanges and to discuss potential next steps with various stakeholders present.

Regional Peer Exchanges

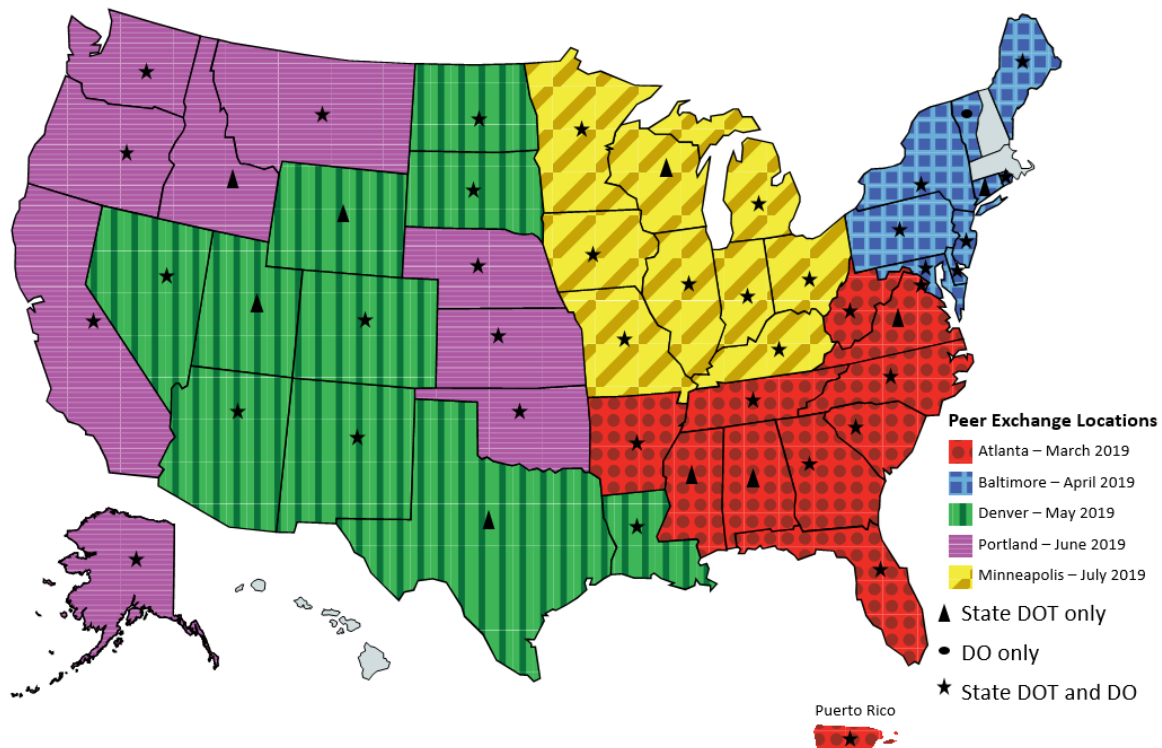


Figure 1. State Departments of Transportation and FHWA Division Offices participating in the 5 regional peer exchanges.

Listening Session Format

In advance of the listening session, participants were sent electronic copies of the Pavement Design Policy and Guidance documents. The following five topics of interest were also provided by FHWA to the listening session participants:

1. What is working with the FHWA Pavement Design Policy and technical guidance? What do you like?
2. What is not working with the FHWA Pavement Design Policy? Where are you having major issues and what challenges do you have?
3. What is needed to address some of the challenges and concerns?
4. Is there anything that, in your organization's opinion, is missing from the Pavement Design Policy or technical guidance that is needed or needs updating?
5. Is there anything else you would like us to know, or be aware of, or add related to pavement design issues?

The listening session was divided into three rounds. In the first round, speakers provided prepared statements addressing the five topics of interest. In the second round, speakers had the opportunity to clarify positions or add to their previous statements after hearing what was said in round one. The third round allowed for interactivity, as a more general discussion took place among participants with moderated questions based on the topics from rounds one and two that had garnered the most interest or concerns.

Listening Session Summary

A number of common themes emerged from the listening session and the written comments submitted by participants following the event, including flexibility and communication. Several participants indicated that the Policy, non-regulatory supplement (NRS), and technical advisory (TA) are well written and offer State DOTs flexibility and guidance. Safety, durability, and cost effectiveness were noted as important considerations in pavement design. However, interpretations differed on the way cost-effectiveness was considered in pavement design.

Some of the challenges and concerns with the Policy that were discussed include achieving consistency between the CFR, the NRS, and the TA; ensuring references are updated with the latest information; improving the guidance on selecting rehabilitation strategies; and achieving greater uniformity in communication and interpretation by the State DOTs and the FHWA Division Offices.

Specific suggestions for updates to the Policy were offered. Among the additions proposed were expanding the Policy definition to include pavement service life and end of life, and including environmental consideration as part of the definition. More than one participant suggested flexibility for State DOTs could be further increased by changing current language that prevents preservation actions from being employed if they add structural capacity. Participants communicated a desire to include life cycle assessment (LCA), sustainability, and resiliency in drafting policy for pavement design type decisions, but differed somewhat in regard to whether the current timing is right for such inclusions.

Regarding communication, participants generally agreed that the FHWA does a good job of shepherding collaboration between State DOTs on research, innovation, and technology implementation. In terms of

the Policy, they suggested it would be beneficial to build in regular review periods so that new knowledge and innovations can be incorporated.

A general discussion and wrap-up included mentions of the need to consider future transportation innovations that will affect pavement policy over the next 20 years, as well as what matters now to the traveling public, from safety and work zones to pavement smoothness.

Flexibility

There was general concurrence that the Policy gives State DOTs flexibility to develop design procedures that are appropriate for their conditions while still providing an outline of the process and key factors to address. Some participants also liked that the NRS ties design to economic analysis, and specifically to life-cycle cost analysis (LCCA).

Collaboration

Participants noted that enhancing State DOT-to-DOT interactions through peer exchanges, etc., along with putting research into practice, is important.

Innovation

Participants noted that the Policy can help boost innovation and create collaborative environments through incentives for competition, that FHWA field trials are helpful in moving products from research to practice, and that there should be encouragement of research on pavement design and mixtures. Because the low-bid environment does not always encourage innovation, further guidance in the contracting process to encourage innovation would be helpful.

Life Cycle Cost Analysis (LCCA)

Some participants liked that the Policy relates pavement design to both engineering and economic considerations and allows for consideration of safety, durability, and cost effectiveness together with the design. Participants discussed whether Policy should be interpreted as LCCA is required for all designs or if it is optional. Some participants stated that designing in a cost-effective manner implies that LCCA is required, whereas other participants did not agree with that assessment. However, the ability to include cost effectiveness through LCCA or otherwise was noted as important. One participant suggested including calculation of user costs due to pavement vehicle interaction in the NRS, while another suggested including costs due to user delays during maintenance, rehabilitation, and reconstruction. Some participants indicated, and no one dissented that more guidance could be added to the LCCA guidelines to include the latest information and best practices. There was not agreement as to whether the Policy or regulation is consistent in encouraging consideration of a broad range of materials.

Alternate Bidding and LCCA Bid Adjustment

There was not agreement as to whether the current language on commodity price adjustment clauses/LCCA bid adjustments and material quantities was appropriate, with participants citing different research/studies as the basis for their positions.

Sustainability

Sustainability was recognized as an important strategy and it was discussed by participants as to whether or not it should be included in the Policy. There was not consensus regarding increased emphasis on recycled materials and reuse of materials, with some pointing out that recyclability does not automatically equal sustainability and, just as with LCCA, the numbers should be run to determine the best alternative.

Some participants indicated that the Policy/regulation definition should be kept at a high level. There was not agreement regarding whether some sort of environmental consideration should be included. Sustainability and resiliency should be taken into account but left open and kept general. While some stated that inclusion of sustainability and resiliency was necessary and a good idea, others stated that the science was not ready and there were too many missing pieces. There was disagreement on whether FHWA should help State DOTs move towards sustainability and resiliency versus putting it in a regulation or rule.

Life Cycle Assessment (LCA)

Participants were very supportive of LCA, but were not in agreement as to whether it is ready to be included in the Policy and TA at this time. LCA could be considered as an addition to the NRS in the future.

Expected Service Life

Some participants noted that the Policy should include indication of the design period, in terms of what service life is expected and it should be tied to performance expectation either in the definition or in the NRS, and that the addition of service life to the Policy should also consider end of life. If service life is included in terms of years, it should account for changes in level of traffic. However, some disagreed over whether consideration of service life should be mandated by Policy or whether there should be incentives provided to agencies to do so.

Asset Management, Preservation, Structural Capacity

Some participants indicated that the inclusion of asset management principles is a positive, but also that there are existing issues with the way the process is currently implemented (e.g., it fosters a “worst first” type of strategy, overly focuses on preservation, and certain preservation choices may be excluded from preservation funding because they also add structural capacity).

Rehabilitation

Some participants agreed there should be recognition that design consideration should reflect just the rehabilitation of the upper layer to be able to use the existing foundation when appropriate. There was broad agreement that foundation is a very important consideration during design and that State DOTs could use more guidance in the NRS on pavement structure, tied to the different ways to account for end of life. One participant suggested defining “major rehabilitation” in terms of “at least one full major rehabilitation cycle.”

Pavement Design Methods

Participants noted that local calibration of AASHTOWare® Pavement ME Design needs to be done. One participant suggested that guidance needs to say “use whatever is best out there” to encourage a holistic, life cycle thinking approach. It was broadly agreed that significant updates in this portion of the NRS is needed, including updating to Pavement ME Design and including guidance to encourage local calibration for equivalent designs. There was overall concurrence that Pavement ME Design is the most scientifically robust design software available but that other methodologies can and should be used. Modeling issues and calibration efforts may make some State DOTs reluctant to accept all or part of Pavement ME Design, so an interim solution is needed. An area where FHWA can provide more guidance is in design equivalence, i.e. when are two designs equivalent.

Road User Consistency

Some agreement that design objectives and rehabilitation expectations should be consistent from State DOT to State DOT, because the Interstate Highway System crosses all States and users expect uniform performance. There was general concurrence that surface texture/smoothness is important to users and should be considered, but improving performance needs to be looked at holistically as part of asset management and against other needs, such as increasing capacity and other factors that matter to the driving public.

Safety

General agreement that safety considerations within current pavement designs are adequate. Suggestion was that safety may need greater consideration, because of increased national emphasis on safety.

Emerging Technologies

Many emerging technology topics were discussed in terms of their relevance to Policy. Overall, participants indicated that designing pavements for automated vehicles currently does not need to be in the Policy. Participants did note that there is a need to prepare for the impacts of automated vehicles on pavement design along with other future changes such as roadway uses, which are expanding from just being a surface to carry traffic loads to include other functions such as —storm water capture, energy storage, charging electric vehicles, or a communications backbone.

Policy Review Process

There was broad agreement that in general there should be more frequent reviews of the Policy to better keep up with industry changes and allow new knowledge and innovations to be incorporated. Participants suggested AASHTO be involved in reviews.

Interpretation / Communication

There were different interpretations by participants as to whether the intent of the Policy is as a mandate requiring that all of the listed factors must be considered. There were also discussions on whether the NRS and TA were mandates or guidance. There was broad agreement that it is important to clarify and communicate what is a regulation or mandate and what is guidance, and ensure regulations/mandates are consistently interpreted and guidance clarified and utilized by the FHWA Division Offices and the State DOTs.

Peer Exchange Format

Peer exchange participants received electronic copies of the Pavement Design Policy and Guidance documents in advance of the peer exchanges along with the same five discussion topics provided to the listening session participants. Each peer exchange was 1½-days long. The peer exchange format was designed to encourage participants to think outside the box when it comes to pavement design policy and to encourage interaction, dialog, and information exchange with FHWA and each other. The format was based on a “Why-How-What” structure. To start, the “Why” focused on the big picture: Why are we all here? This included the DOT’s high-level missions or goals for their transportation networks, specifically pertaining to pavements. The “How” focused on strategies needed to meet these missions and goals, as well as the barriers participants encounter to doing what is ideal, from a pavement design perspective. The “Why” and “How” helped prime participants for the central purpose of the peer exchange—the “What,” which included discussions on policy, guidelines, research needs, and other tools to achieve their agencies missions and goals.

During the morning session of the first day, following the initial welcome and introductions, the FHWA moderator presented meeting objectives and expectations from participants. The moderator mentioned that “parking lot” pads of paper were placed around the room for participants to note any ideas that needed to be discussed during the peer exchange, such as research needs, technical guidance, education or other issues. Participants were then divided into four groups for the first of three breakout sessions. To enhance dialog and offer a balanced viewpoint, moderators ensured that DOT and FHWA Division Office representatives from the same State were in the same breakout group.

During the first breakout, the groups were tasked with discussing the prompted focus question: “What is the State Department of Transportation’s mission?” An FHWA moderator was present in each group to facilitate the discussion. At the end of the breakout, one member from each group reported out the discussions that occurred within their group to the other peer exchange participants. During the second breakout, each group was tasked with discussing the prompted focus question: “What strategies are needed to meet the goals identified from the first breakout and overcome current barriers to accomplish these strategies?” Again, each of the four breakout groups was facilitated by an FHWA moderator, and one member from each group reported out the discussions that occurred within their group to the other peer exchange participants.

In the afternoon session of the first day, State DOT and FHWA Division Office representatives discussed key points made during the industry listening session. FHWA explained different tools (statute, guidelines, education and outreach, and future research) and summarized listening session observations. The rest of the afternoon was a moderated open discussion regarding the Policy, including whether the current Policy meets the goals and reflects the strategies discussed previously. Each participant was provided the opportunity to comment on the Policy and on what changes, if any, they would recommend be made to any of the Policy documents.

The morning session Day 2, the final session of the peer exchange, was dedicated to discussing current practices at the DOTs. This took place within the same moderated breakout groups from Day 1, and the current practice information was documented by the FHWA moderators. Finally, each peer exchange participant was provided the opportunity to express their agency’s needs in terms of research, guidance, training, etc. and to identify how FHWA could support those needs in the future.

Peer Exchange Summary

DOT Mission and Values

Southeast Region

In general, the DOTs in this region have mission statements that align with FHWA’s Policy. A recurring theme during the peer exchange was that each DOT has individual needs as well as differences in availability of resources and materials to complete construction projects. They also have different factors to consider that sometimes do not always necessarily align with federally-established policies. These include unique legislative requirements, processes, and procedures. In designing pavements, the DOTs often consider issues related to cost, materials and material availability, contractor market, and political and social environments.

Northeast Region

The State DOT participants generally agreed that their missions and values were consistent with FHWA's Pavement Design Policy. Including safety as a key focus area was suggested, as was a consideration for the efficient use of dollars spent, specifically referring to prioritization, preservation, and preventive maintenance. There was agreement that more focus should be placed on making better decisions to keep the network in a state of good repair. Additionally, many DOT participants agreed that prioritization should be on maintaining existing infrastructure, rather than on adding new capacity.

Quality of life as it pertains to pavements and as it relates to the traveling public was discussed. DOT's missions are built upon transportation excellence, sustainability of the transportation system, and quality of service through communities and customers. With this in mind, the DOT participants agreed that operating safely and efficiently is a work of balance. DOT responsibilities include freight, ports, rail, and transit, and their relationship with these entities requires a balancing act. Project selection requires the same kind of balance to ensure a fair bidding process. They suggested that the transportation network should also aid in economic development, considering it as a circulatory system feeding economic vitality to the community.

Southwest Region

The participating States have similar missions and goals in providing excellent service and a safe and economically sound transportation network. This includes delivering the right projects, focusing on the customer, fostering stewardship, optimizing system performance, preserving assets, promoting safety, and valuing employees. Participants said their States are effective in pavement design and in operating pavement management systems. They noted while their primary focus was on maintaining conditions on highways and urban areas, rural corridors and roads leading to recreational activities also need attention as they currently lack prioritization and funding.

Northwest Region

Representatives stated their State's missions are in line with the Policy, but seek improved consistency in terms of achieving their mission goals. The agencies missions are to meet public needs through improved safety, reduced user delays, increased mobility, reduced costs, and reliability of the network. Agencies discussed commerce and economic movement, modernization, innovation, efficiency, sustainability, transparency, and performing data driven decisions. There is a need for more education, innovative research, and resource sharing. States currently have good practices for socio-economic impact, sustainability, and network wellness. They can meet the mission goals but need consistent funding. Additional FHWA guidance may help States maintain best practices for better use of taxpayer dollars. One challenge is the availability of quality construction materials. Knowledge transfer and clear policies can help. Available tools are not well suited for design of treatments to extend or renew service life.

Midwest Region

The State DOT participants generally agreed with FHWA's current mission and goals in terms of the Policy, in that pavements should be designed in a safe, effective, economical, and durable manner. They suggested the following considerations: innovation, efficiency, reliability, education and research, environment, preservation, structural capacity, cost-effectiveness, industry competition, mobility, and quality of life. They noted that industry competition is beneficial overall toward meeting these goals. Agency focus should be on proper design and maintenance and improved safety. FHWA can play a

supportive role in agencies achieving their mission goals by providing guidance and taking a proactive approach towards education and outreach.

FHWA Policy and Guidance

Southeast Region

The consensus among the DOTs in this region was that the current Policy is acceptable and meets their requirements, but some language could be clarified as to intent. Participants generally agreed the Policy is flexible, open to interpretation, and can be difficult to implement consistently.

Participants discussed the definition of the term “regulation” and there were different interpretations regarding whether the Policy, NRS, and TA are mandatory or guidance. They also discussed whether or not the regulation should remain in place, and if so, how to enforce it. The majority of participants reported the Policy should remain in effect, but discussed potential changes relevant to their States’ missions. In particular, they discussed incorporating additional elements pertaining to innovation, efficiency, reliability, education and research, environmental considerations, structural capacity, and quality of life. One DOT stated that FHWA should consider changing the Policy since it has not changed in years and that an update to the Policy could help be a driver of change. However, this view was expressed by one DOT only and was not supported by other DOTs.

Participants also suggested improvements or revisions be made to the economic analysis. Not all States uniformly use LCCA for pavement design projects. Some participants that use LCCA on applicable projects argued that using LCCA might not reduce overall costs of ownership. Some suggested a revision to economic analysis to make it more flexible, while others do not want to change it. Most participants from this region agree the LCCA should not be applied to every project. They requested guidance or tools to aid in the use of LCCA and with deciding on what projects LCCA is best applied.

Northeast Region

For project-level activities, State DOTs are doing what is in the Policy but are unsure if the Policy applies only to new pavement designs. DOTs accept that it would be difficult to develop a flexible national policy that ensures consistency. There was some discussion on whether there is even a need for this regulation, and if it is too prescriptive for engineers who are licensed to perform pavement design and know all the factors that have to be considered. Participants said they like the flexibility the current Policy allows. Several participants said the definition does not have to be in the Policy. They would like to see each State required to have a written policy but recommended that FHWA develop a checklist of minimum requirements to make the requirements clear and consistent. Sustainability and inclusion of environmental impacts and “cost-effective” in life cycle planning were deliberated at length. It was mentioned that “environment” should not have dollar figures associated with it and should be left to engineering judgment.

Participants suggested that the Policy should clearly identify its applicability, in terms of whether it is applicable only to new pavements, or also to reconstruction, rehabilitation, and preventive maintenance. Participants said that it may help to remove “life cycle” from in front of “cost,” leaving it just cost. One participant stated that under the Policy, cost-effective means to ensure a certain amount of life out of the cost, whereas another participant mentioned their State has processes for doing the “cost-effective” part.

There was also discussions on pavement design and licensure. Because States regulate design and engineering under State laws, having a pavement design definition in the Policy was thought to be

redundant. The beginning of the CFR states that all Federal aid work is to be carried out in accordance with Federal and State law, and the Federal Government does not regulate the profession of engineering, the States do.

In terms of the NRS, participants agreed that future considerations should not be included at this time. This would rely too much on guessing as to what is coming, which there is not enough information for now. Consensus was that this is a guidance document, and guidance documents are not meant to be used to plan for the future. If discussion is needed, this should be addressed every 10 years.

Southwest Region

Participants candidly discussed the Policy and regulation, the relationship between Transportation Asset Management Plan (TAMP) under Title 23 and Policy, and how each affects the other. They questioned whether there is a need for a “cost-effectiveness” section in the Policy, and whether States are using life-cycle planning. During the discussion, participants examined whether the Policy should remain in effect. They suggested the Policy language is vague and should be re-written.

Participants acknowledged they do not always consider all factors when performing pavement design. Materials, traffic, climate, maintenance, drainage, and life cycle cost are the most common being considered. They indicated they are generally dissatisfied with current practices and the use of LCCA. Participants suggested there is industry pressure to use LCCA for all transportation projects. They discussed and defined the difference between “life cycle costs” and LCCA. Clarification was requested in project type selection when using LCCA to aid in cost-effective decisions.

Participants discussed both the positive and negative outcomes if the Policy is removed. They agreed that flexibility is a benefit of autonomy, but the Policy also provides benefits in helping enforce standards and having Federal Government support when pressured by industry. It was suggested that FHWA could clarify the Policy by changing words and phrasing, for example changing “which are” to “which may be.” Participants generally agreed that some guidance is good, and there needs to be some flexibility allowed by the Federal Government. It was suggested that the definitions in the policy could be deleted. Participants discussed removing cost effectiveness from the Policy if life cycle costs are factored into the States’ pavement design policies. Overall, most participants want to keep the Policy, conditional on FHWA re-writing language to fix ambiguity and adding wording that can help prevent misinterpretation.

Participants discussed the non-regulatory supplement (NRS) in relation to their missions and strategies and to whether it lines up with Policy. There was consensus that the supplement includes too much narrative, and they suggested “sticking to the facts.” They recommended engineering judgment be left up to the States. Pavement ME Design was discussed as a barrier for some States due to cost and calibration of the tool. As written now, the supplement, in addition to the Policy, gives the impression that States must conduct LCCA for all pavement projects. Discussion indicated most participants thought LCCA is mandated.

In regards to LCCA programs, most of the States do not measure user cost in their processes. Participants discussed how the use of different discount rates can be an obstacle. When asked about life cycle cost, several commented they do not use life cycle cost, or use it only on a district-by-district basis. States evaluate alternative bidding and consider the consequences of the project; however, this is not accomplished by doing LCCA. It was identified that the use of LCCA is usually determined by funding

availability and source. Participants discussed surface finishing and its relationship to safety in design. In the end, participants asked about ways to be more consistent in their LCCA.

Northwest Region

Overall, participants said the Policy is good and most of what is in it is in the States' design manuals. There were concerns that removing policy may lower the standard of minimum design. Participants concluded that if the Policy is meant to be used, it needs to remain regulatory. States find it useful to have the FHWA Policy to help local agencies meet standards, even if Federal funds are not used for that specific project.

The group discussed life cycle costs and LCCA, and agreed that exact wording should be added to the Policy regarding LCCA. Many States in this region have their own policies for design, however, some do not. It was identified that FHWA Division Offices interpret policy differently, which was recognized as a communication and interpretation concern. Currently, participants thought FHWA Divisions are not consistently interpreting life cycle costs in the definition or in the supplement. Improved clarification of life cycle costs and LCCA in the Policy could provide flexibility and consistency for future projects. If LCCA/life cycle costs are going to remain in the policy, communication should be transparent. Some States have life cycle costs clearly defined in their policies, but others do not. Many States in this region do not consider life cycle costs on all projects. Clarity and communication were identified as keystones to policy.

During discussion on flexibility in policy, States said the Policy is "too ambiguous" and needs to be clarified in areas. However, flexibility needs to be maintained, and in some cases added. For example, adding the word "may" so that it reads "factors considered *may* include." There was general agreement that the supplement will be helpful to agencies with minor changes to the definition and clarifying language.

Participants discussed pavement type selection, referring to the supplement for life cycle cost. Agencies deliberated on whether a project must be bid as one for asphalt and one for concrete, however, discussion clarified that a bid could include one of each (asphalt or concrete), or include two different types of asphalt or two of concrete.

Participants suggested that wording on new construction, maintenance, and rehabilitation should be considered and added into the Policy while service life criteria should also be defined in the Policy. Some participants stated that Policy should consider future needs, within the next 20 years, and incorporate a plan for any challenges that agencies may face. State agencies need strategies for dealing with the issues and opportunities that arise. For example, autonomous vehicle pavements: states need to learn what is expected of pavement design in the future for these vehicles.

Midwest Region

During discussion on flexibility in policy, participants said the policy is "too ambiguous." They suggested changing wording to incorporate more engineering language instead of language for the lawyers. Participants said the NRS would be helpful with minor changes and modernization of some content. Some would like to see the supplement converted to a list format. Participants expressed a desire for it to stay flexible for use as a technical guide for current and future work. This supplement could also be helpful as a guide for incoming administrative leadership, as most presently come in without pavement engineering experience.

The Policy should highlight consistency in safety and saving lives. FHWA could test methods used for measuring friction and provide States with a clear understanding of what that friction needs to be to help

reduce fatalities. Also, FHWA should promote competition in anything produced for the States. Competition improves the opportunity for innovation and brings a fair and level playing field for all.

The group discussed cost-effectiveness, and the consensus was to remove “life-cycle cost” from the definition, and only include a statement about cost within the policy. An agency could perform cost analysis in their own manner and not necessarily use LCCA. Each State could be required to have its own cost-effective assessment process, as long it is defensible.

Barriers, Strategies, and Needs

Southeast Region

Most agreed FHWA should have a supporting role in pavement design and should emphasize innovation within the Policy. Participant States have little or no direct reviews from FHWA Division Offices for pavement design on individual projects, but the FHWA Division Offices review their overall pavement design policies. As a result, there has been declining interaction between FHWA and DOT representatives in recent years concerning pavement design.

The relationships between the DOTs and consultants/contractors also vary from one State to another, in terms of the extent and type of pavement design work performed. Pavement design is often influenced by State legislation, State-selected pavement type preferences (either asphalt or concrete), and historical practices. This relationship can have both a positive and negative effect on individual States, specifically relating to staff retention and turnover, as well as education and training.

Collectively, participants from States in this region report DOT staff are receiving needed training on-the-job, but then tend to leave their State jobs for the private sector. This becomes problematic with State DOTs not having the necessary time to train new employees. As a result, States are reluctant to train new staff on products such as the Mechanistic-Empirical Pavement Design Guide (MEPDG) / Pavement ME Design. Another challenge has been that consultants sometimes do not want to take the time to do a proper pavement design and therefore end up proposing an oversized pavement structure.

Participants pointed out that the variety of design software available can be a barrier to proper and standard use. They noted the lack of standard use of these specific programs is often due to the cost of the software itself, training on the software, and/or the inconsistent and varying results produced by the software. As a result, States use software based on preference and past experience. In some cases, States have developed their own unique software or tool based on their specific needs.

Participants affirmed the idea of more education and training, including national and regional peer exchanges or conferences, to remain current and connected with leading industry practices, innovations, and other partnering opportunities. Participants also acknowledged positive results with Every Day Counts innovations, data driven safety analysis, and SHRP-2 programs promoted by FHWA. Future pavement design research topics suggested to FHWA included platooning truck fleets, resiliency, automated vehicles, and detectable pavement markings.

Northeast Region

Participants remarked on FHWA’s role as a steward for quality and a checkpoint for DOTs and recommended FHWA provide additional guidance or communication on best practices, instruction on how best to use LCCA, and education and promotion of new technologies that help DOTs become more effective.

Additional discussion focused on future goals in terms of workforce development, educating the public, and investing in pavement performance research to improve innovation and data collection. There was consensus among DOT participants that there is a need for agencies to learn to adapt to new technologies and embrace change. Participants want FHWA to be a leader in helping identify innovations that can help DOTs be more effective. They want FHWA to stay abreast on not just national best practices but also international best practices and to help assess the technologies and transfer that knowledge to the DOTs and other stakeholders.

Topics discussed included threat assessment, sustainability, and user and customer involvement at the project level. According to participants, most States have mechanisms in place to listen to the community. Discussion arose on resiliency, including defining what it means for a roadway to be resilient and managing natural and human-made threats to the network. The DOT participants related that decisions are sometimes politically driven, rather than data driven which could increase efficiency.

Southwest Region

Participants from the DOTs said they are active with their States' TAMP and have dialog with their State FHWA Division Office representatives, who provide guidance and tools as needed. However, they said it would be beneficial if FHWA provided additional technical support and training opportunities for new employees. Participants considered future economic needs and discussed projected and future traffic volumes and heavier truck loads, as well as the use of autonomous vehicles.

Participants also defined and identified strategies and barriers to implementing pavement design policy. Strategy topics included design that includes sustainability and resiliency, accurate traffic/historical data, knowledge and education transfer between disciplines, increased cost-effectiveness and reliability, the need to be environmentally responsible and economically driven, and the need to provide safe public transportation for moving people and goods. Barriers identified included collecting traffic data and forecasting traffic, fluctuating industry prices, an increase in heavy-truck traffic in areas not built for the weight, and a continuing loss of top leadership positions within the DOTs. When there is a change in administrative leaders, this often results in subsequent changes to policy. Participants identified budget concerns as another barrier and discussed FHWA providing supplemental funding.

State DOT participants shared best practices and successes with the group. Several States have developed their own work plans and "best practice" manuals. One State has decentralized districts with varying pavement design policy/guidance within each district, but the State has a quality control program to help with consistency. One participant requested assistance with developing a Long-Term Pavement Program specifically related to calibration needs. Needs were identified for additional resources for training and education. Participants discussed recycling methods in terms of sustainability and maintaining pavement thickness on bridge approaches over time. They elaborated on LCCA practices and on including the industry representatives in formal decision-making, or at least during the review process.

Northwest Region

States said they can meet the Policy goals but requested consistent funding. A stated concern was how to maintain best practices for better use of taxpayer dollars, for which they requested additional guidance from FHWA. One challenge participants consistently raised was availability of quality construction materials. Additionally, clear policies and transfer of knowledge can aid DOTs.

The DOT participants discussed challenges they face with tools and models for rehabilitation and preservation, and they noted current pavement design methods do not accurately model in-service asphalt pavements for extending service life. Uncertainty with Pavement ME Design calibrations and general design qualifications was discussed. Participants said past methodologies were more flexible, but Pavement ME Design results are perceived to be more exact.

When working with contractors and consultants on pavement preservation, agencies have discovered that not all contractors/consultants know each State's individual life cycles for asphalt and concrete, which can be a challenge for proper treatment selection.

Participants reported that, in most cases, funding for projects is an issue. Establishing dedicated truck lanes as well as increasing density specifications in materials were discussed to help improve overall pavement life. Contractors not familiar with new techniques or processes, was another limitation mentioned for States.

During the discussion on strategies, participants noted the importance of recycling, keeping in mind the economic and environmental effects and material availability. Reusing existing materials is important for States that lack a good aggregate source; therefore reusing materials was identified as a potential strategy, but it should be better supported with improved pavement design tools. Participants commented that available tools are not well suited for design of treatments to extend or renew service life.

Noted good practices in place in the States concern consideration of socio-economic impact, sustainability, and network wellness. These items had not previously been considered in the design process. Improving documentation of experiences and research evaluation on projects and sharing the results and judgments can increase knowledge transfer in agency departments and to the next generation of engineers.

Participants discussed that State DOTs need to spend their money on the right road at the right time using performance management principles. Project bundling was referenced as a strategy to keep the per-mile cost down for State budgets. Participants acknowledged that bundled projects may have more upfront costs which needs to be budgeted for during the next financial commitment cycle. State DOTs and FHWA Division Office representatives discussed surface treatments and determining what local inputs to use on types of materials.

Participants agreed that improved communication within a State agency is critical. Maintaining good working relationships with staff in other State agencies and with contractors was suggested as a way to help keep all parties on the same page.

Midwest Region

Support requested from FHWA included more opportunities for training on new and existing pavement design software and better tracking of special "workarounds" while using Pavement ME Design. More research would be helpful on the subgrade part of the pavement design arena. Additional research and background on hot in-place recycling is needed.

States discussed several barriers to effective pavement design, including funding, which is one of the major issues they deal with daily. The competition for dollars on future projects and sometimes having to share those funds with competing bridge work in this region was discussed. The public perception of

funding within the DOTs is that they have enough funds, but in reality, they do not have enough to sustain their systems. In addition, increased reliance on consultants is expensive and some lack the knowledge and expertise needed to be effective. Work zone safety requirements were identified as a barrier for optimum design. DOTs cannot build what they want to due to work zone safety policies. Limited lane closures and restrictions on traffic flow impact the quality and life cycle of some projects.

The current and upcoming wave of retiree turnover was also an identified barrier, due to the training and experience needed to continue efficient pavement design. Lack of succession plans, no continuity, and employees moving to other companies as soon as they are trained was discussed as well. One State has developed a “Book of Knowledge” as a means for successfully training new personnel and lessening the loss of workforce knowledge caused by staff turnover and retirements. Innovation can sometimes be a barrier due to high initial cost of introducing new innovations on projects and the lack of new data for proper design. Communication can be a barrier for States with many districts due to distance from each other and from Central Office, and due to fundamental differences.

During a discussion on strategies, participants noted safety as a primary concern and suggested friction management and testing was an area where FHWA and its Division Offices could be more proactive. Work zone safety for the public, contractors, and DOT personnel was also a top concern. Effective communication was discussed as key to developing the type of understanding that keeps DOT staff, upper management, and industry on the same page in terms of pavement requirements. Public involvement on larger projects was a discussed strategy to inform the public and provide for their input when choosing a maintenance-of-traffic approach. Strategies for gaining efficiency included alternate bidding to stimulate competition and lower cost as well as using performance based planning processes with pavement designs.

National Workshop Format

During this 1-day session, participants were divided into groups for four breakout sessions. To enhance dialog and offer a balanced regional representation, moderators saw to it that industry representatives from the same industry and DOT/FHWA Division Office representatives from the same peer exchange region were grouped together. During the morning session, following initial welcome and introductions, the moderator presented meeting objectives and expectations to participants. During the first breakout, each group was tasked with discussing the prompted focus questions concerning *Pavement Design Considerations and Procedures*. For State and FHWA Division Office participants, the questions included:

1. What are the challenges in your region with respect to pavement design?
2. What types of projects require structural pavement designs in your region? (reconstruction, new construction, rehabilitation, or preservation)
3. Who is responsible for performing pavement design?
4. Which design tools/software programs are used?

For industry participants, the questions included:

1. What are the challenges in pavement design with respect to your industry?
2. What type of projects do you think should be designed?
3. What types of tools are best to use for design?

At the end of the breakout, one member from each group reported out the discussions that occurred within their group to the other workshop participants. During the second breakout, each group was tasked with discussing the prompted focus questions concerning *Cost Analysis, Cost Effectiveness, and Life Cycle Cost Analysis*. The questions included:

1. What are the challenges in your region with respect to cost analysis / LCCA?
2. Does cost effectiveness equal LCCA, or are there other techniques to evaluate cost effectiveness?
3. What types of projects are cost analyses performed on in your region?
4. Who is responsible for performing cost analysis?
5. What design tools / software are used?

Again, each of the breakout groups discussed this question and one member from each group reported out the discussions that occurred within their group to the other workshop participants. In the afternoon session, each group was tasked with discussing the prompted focus questions on the *FHWA Pavement Design Policy*. The questions included:

1. What were the discussions in your peer exchange relevant to the Policy?
2. What were some ideas/suggestions?
3. What were the issues and what was the consensus (if any)?
4. Develop a list of items – did any stand out in terms of priority?

The rest of the afternoon, each group was tasked with discussing prompted focus questions that addressed *Other Considerations*, wherein each region and industry was provided the opportunity to express their needs in terms of research, guidance, training, etc., and how FHWA could support those needs in the future. The questions included:

1. What were some other items discussed during your peer exchange?
2. How can FHWA help move some of these items and address your concerns relative to these items?

National Workshop Summary

Workshop participants stated that funding, lack of expertise, and climate change impacts are primary concerns with respect to pavement design. One participant stated that there are currently no generally accepted national standards governing pavement design, resulting in every State approaching pavement design differently. Barriers with implementing Pavement ME Design are also a concern for some States and industries.

Many States only perform pavement design for new construction and reconstruction, and in most regions, the majority of projects are rehabilitation and preservation. Across the United States, there is a mix of consultants and agency engineers responsible for performing pavement design. For those using Pavement ME Design, the challenge is not necessarily the software but its level of complexity in that it requires many inputs, characterization of materials, local calibration, and proper quantification of design reliability. While both the asphalt and concrete industries have developed their own pavement design tools, the concrete industry's preferred tool is Pavement ME Design, and the concrete industry encourages Pavement ME Design's universal adoption. The concrete industry also stipulated that there is no reason why an agency cannot implement Pavement ME Design for concrete pavement, simply because the

agency is not comfortable with the asphalt portion of the software. The asphalt industry stated that there are discrepancies and challenges States have encountered while using Pavement ME Design. The asphalt industry supports Pavement ME Design only when it is coupled with local calibration. The asphalt industry has concerns regarding a few of the models that need additional validation, but the asphalt industry likes the concepts of mechanistic-empirical design.

During the discussion on cost analysis, cost effectiveness, and LCCA, the challenges mentioned included staffing, especially junior staff's understanding of future preservation cycles; regional microclimates that impact performance in ways that are not properly considered; and the multiple factors and inputs needed for LCCA. For some States, the challenge with LCCAs is just getting them done on many of the projects. LCCA is most commonly performed on new and major rehabilitation projects, but not on preservation projects. State representatives differentiated LCCA from cost analysis in that they considered LCCA as a more rigorous process with defined inputs, while cost effectiveness was considered less rigorous and more of an evaluation of "costs and reason for costs." The concrete industry underscored that LCCA is the best documented and understood means of establishing cost effectiveness. While a few States maintained that LCCA is the best method for determining cost effectiveness, all States agreed that there are other methodologies that can be used in lieu of LCCA, such as historical data, past experience, and engineering judgment.

The concrete industry representatives stated that LCCAs are not being performed early in the design process, and that this is due partly to States not having the proper data, cost information, or correct maintenance and rehabilitation scenarios for performing LCCA. There is also a tendency by some States to simply assume the outcome, and therefore never actually perform the LCCA. This, in the concrete industry's perspective, is inconsistent with requirements in the Policy. The asphalt industry's stated concerns were focused on the challenges associated with not having quality historical data in the pavement management system and, once an LCCA is completed on a project, the lack of follow-up as to whether the LCCA assumptions were correct.

During a discussion on tools or metrics used for evaluating design cost effectiveness and whether cost effectiveness means LCCA, the consensus among the States was that cost effectiveness does not necessarily mean LCCA. State representatives indicated there is not a one-size-fits-all method for cost analysis in pavements, and performing LCCA does not guarantee the design is truly cost effective for the project. Some States perform LCCA on major investments and large projects, and for smaller projects, they use engineering judgment or consider annualized costs. The concrete industry representatives suggested that cost effectiveness means LCCA because cost effectiveness includes costs and performance outcomes, so LCCA is a metric that can be used for balanced comparison. The asphalt industry representatives stated that other techniques and methodologies, such as systematic analysis at the entire network level rather than project-level analysis, should be considered while evaluating costs.

When discussing what project types require cost analysis, most of the State participants said they perform LCCA on large projects and major investments. One of the States performs LCCA on every project; others may perform some type of cost analysis, but not necessarily LCCA. Whether LCCA is performed for rehabilitation projects differs, as policy decisions within States focus on selecting the right materials and treatments and analyzing the costs. The concrete industry representatives said that cost analysis should be performed on as many projects as possible, and it should begin during the design phase. They added that States are already spending millions of dollars on actual construction costs, and opined that the small

amount of time and money used to perform an LCCA is a good investment. The asphalt industry representatives said that FHWA should provide more guidance and training on LCCA, and that a probabilistic analysis is a better way to perform LCCA, but only if the data is accurate and reliable.

Responsibility for performing cost analysis in almost all States falls on the pavement designer for that particular project. One participant said that with the new Transportation Asset Management Plan (TAMP) requirements, there is a shift in responsibility to asset managers as they are also looking at the network level to ensure strategic use of funds when selecting projects. Industry representatives stated that State DOTs should be responsible, but FHWA should ensure States are following best practices and looking at variability, uncertainties, and reasonable estimates for cost analysis of their design. Tools used by States for performing cost analysis include FHWA's RealCost software, spreadsheets, probabilistic or deterministic analyses with different parametric evaluations, and agency-developed tools. The concrete industry has a software tool that is used for lower-volume roads and is available to the States. The asphalt industry representatives mentioned there are many software tools, but States need to know the difference between good data and bad data to input into these tools. It was suggested that FHWA should develop a guidebook with recommendations on how to use these tools effectively.

When discussing the Policy, most State participants said they would like to see the Policy and Guidance updated to address current ambiguity but would also like to see it kept flexible and not be made binding so as not to potentially stifle innovation. They indicated they do not want to be overly regulated through the Policy via too many requirements or restrictions. Regarding the CFR's pavement definition that reads, "shall be designed in a safe, durable, and cost-effective manner," States would like FHWA to better define those parameters to reduce ambiguity in the Policy. During a discussion on pavement foundations, participants recommended that foundations be properly addressed in the Policy to ensure adequate consideration of base and subbase in pavement design. Both industries agree with the content of the Policy. The asphalt industry would like FHWA to address updates to the LCCA guidelines and mention in the non-regulatory supplement that the engineering evaluation should include recycled materials, on which FHWA already has a policy. The concrete industry believes the Policy is written clearly, but also suggests that it is important for FHWA to assert its authority and ensure States are performing pavement design by considering both the engineering and economic considerations, as required by the Policy, and not just selecting combinations of materials without an adequate economic analysis. Per the concrete industry, just as FHWA would not allow for a pavement design to be performed without traffic data, they should also not allow for pavement designs to be performed without determining it is being done in a "cost effective manner." One DOT participant responded that economic consideration is a subset of engineering consideration, rather than a separate item. Engineering encompasses many things besides materials and thicknesses; it includes economics, constructability, maintenance of traffic, and future preservation/rehabilitation. Workshop participants agreed that the non-regulatory supplement is outdated and needs to be updated.

When asked what FHWA could do to assist the States, the DOT participants suggested FHWA produce more guidelines and publish more best practices, as well as conduct more peer exchanges for face-to-face exchange of information. They also suggested FHWA establish recognition or incentive programs for various industries to work together and develop innovative ideas, design methods, and better products for the future. States would also like assistance in local calibrations, use of new technologies in construction, long-term data collection, and technology transfer. The concrete industry representatives suggested FHWA recognize and address new ideas formulated around sustainability and resiliency. They

stated that industry can be leaders in developing innovative materials, ideas, equipment, technologies, and practices, but guidance documents and best practices need FHWA's leadership to present innovation in a broader perspective to the various stakeholders. FHWA policies should encourage competition between industries that can be readily implemented at the State level.

In concurrence with most of the workshop participants, those from the asphalt industry would like to see the Policy revisited more often than the 20 years it has been since the last update. The asphalt industry said that the Policy should reflect progress; however, life cycle assessment, sustainability, and resiliency are not ready for inclusion into Policy. They would like FHWA to help States develop a data program so States will have proper programmatic or network-level data to perform LCCA and compare both life cycle costs and performance of different design scenarios.

Next Steps

All of the reports from the listening session, the peer exchanges, and the national workshop will be posted on FHWA's website. FHWA, as of now, does not have a tentative timeframe for "next steps" but is committed to working on solutions for issues heard during the listening session, peer exchanges, and national workshop.