

**2007 National Winter Maintenance Peer Exchange  
Final Report**

by

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A report prepared for the  
2007 National Winter Maintenance Peer Exchange Steering Committee

February 25, 2008

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## EXECUTIVE SUMMARY

During the past decade since the completion of the winter maintenance operations portion of the Strategic Highway Research Program (SHRP) and the subsequent field test and evaluations (TE-28) by the Federal Highway Administration, there have been major improvements in winter maintenance operations. Every state Department of Transportation has adopted some portion of the SHRP research effort as the winter maintenance community has shifted from a reactive to a proactive approach to snow and ice control operations.

As each state made its journey to proactive snow and ice control operations, new equipment needed to be developed, new chemistry came into the marketplace, and new methods of technology transfer were implemented. While the progress has been phenomenal there was a need to bring state DOT snow and ice control experts and the private sector providing equipment and materials together to share information and network on snow and ice control related issues. There was also a need to bring research organizations into the discussion so they would understand where the communication, knowledge and technology gaps existed so strategies could be developed to bridge those gaps.

To this end, the National Winter Maintenance Peer Exchange, held in Columbus, Ohio, Aug. 29-30, 2007, in conjunction with the 12<sup>th</sup> Annual Eastern Snow Expo, was a great success. Many thanks go to the sponsoring partners that contributed their time and expertise to make this a unique and meaningful experience for the 86 attendees, who came from 35 states as diverse and far away as Maine, Texas and Alaska. These true peers brought a broad array of experience, from frontline snow fighters and foremen to department chiefs. They came to talk about problems, get the problems discussed by their peers, have the problem prioritized relative to other states' problems and, finally, have the problems be presented to the researchers who can take up the challenges, and to the vendors who supply the winter maintenance equipment and technologies.

“This concept is on track,” said one attendee. “Shared knowledge and experience helps set the direction for future research and implementation. Kudos!” Another said, “Your attendees leave better informed and better connected, as well as reinvigorated.”

To help focus the National Peer Exchange discussion and insure attendees were ready to “hit the deck running,” preliminary surveys were used to determine the most pressing needs and challenges seen by each state DOT. Members of our steering committee then analyzed and refined the survey results, and came up with four focus group tracks to organize the discussion:

- Increasing Expectations, Performance Measures and Environmental Impacts;
- Decision Making Skills, Dealing with Refreeze and Equipment;
- Staffing Issues, Training Challenges and Communicating to the Crews;
- Weather and Forecasting, Consistency and Data Collection.

At the start of the conference, representatives of the research consortiums made opening session presentations summarizing their program accomplishments and abilities to help in solving research gaps. Then the four focus groups, or round tables, were convened to debate and discuss research priorities. These generated 70 research problem statements. The 70 statements were then prioritized, and the steering committee grouped them into 27 consolidated research problem statements. These 27 research problem statements, again, notable for having been generated by winter maintenance field personnel and DOT staff, were each assigned to one of the participating research consortiums for consideration in their funding programs.

The research groups that participated included the American Association of State Highway and Transportation Officials (AASHTO), Aurora, Clear Roads, Pacific Northwest Snowfighters (PNS), Snow and Ice Pooled Fund Cooperative Program (SICOP), and the Transportation Research Board.

Progress on consideration and funding the research problem statements can be followed by visiting the National Winter Maintenance Peer Exchange web site at <http://www.wti.montana.edu/TechnologyTransfer/2007PeerExchange.aspx>.

## 1. INTRODUCTION AND PURPOSE

The New Year was only a few hours old and a menacing mass of dense, cold air was poised over the nation's Northeast. Rising to meet it was a large low pressure system, drawing warm ocean air off the Atlantic. The signs were so dire that heads-up calls were coming in from weather agencies as far away as Europe. The National Weather Service began warning transportation departments up and down the Eastern seaboard that trouble was coming.

The "Blizzard of '96" packed a punch. Snowfall records were broken from Georgia to Maine, with as much as four feet blanketing parts of West Virginia. Roads were closed, commerce stopped, and much of the East was at a standstill. More than 100,000 Federal employees couldn't make it to work in Washington, D.C., alone. The Nor'easter was followed a couple of days later by an Alberta Clipper bringing cold Canadian air and even more snow to the region. In the end, 187 people were dead and the damage toll reached \$3 billion.

In the wake of the storm, Federal Highway Administration (FHWA) staff decided a forum was needed where city, state and federal officials could exchange information on how best to deal with major snowstorms. That same year, 1996, FHWA inaugurated the Eastern Snow Expo, an annual symposium to allow local agencies to share strategies and techniques, practitioners to discuss the latest technologies in winter road maintenance, and vendors to spotlight all the latest equipment.

This year, the 12<sup>th</sup> Annual Eastern Snow Expo, held in Columbus, Ohio, added a component designed to help push winter road maintenance technology forward. The National Winter Maintenance Peer Exchange convened for the first time this summer, thanks to a partnership between many of the entities actively involved in winter maintenance research issues, including the Aurora Pooled Fund, Center for Transportation Research and Education (CTRE) at Iowa State University, Clear Roads pooled fund, FHWA, the Pacific Northwest Snowfighters Association (PNS), the American Association of State Highway and Transportation Officials (AASHTO), Snow and Ice Pooled Fund Cooperative Program (SICOP), CTC & Associates, and the Western Transportation Institute (WTI) at Montana State University.

The idea for the meeting started with Dennis Burkheimer, Iowa DOT Winter Operations Administrator. "I guess it has always been a desire of mine to have a national meeting where all states would have the opportunity to learn about research being done in this area, identify and prioritize winter maintenance problems at the national level and get to know their peers," Burkheimer said. "Cities and counties have national events that allow them to learn and share but state DOTs have never had that opportunity in winter maintenance."

Burkheimer, who represents Iowa DOT on the Clear Roads Technical Advisory Committee, co-chaired the conference with Diana Clonch, Snow and Ice Coordinator for the Ohio DOT, and

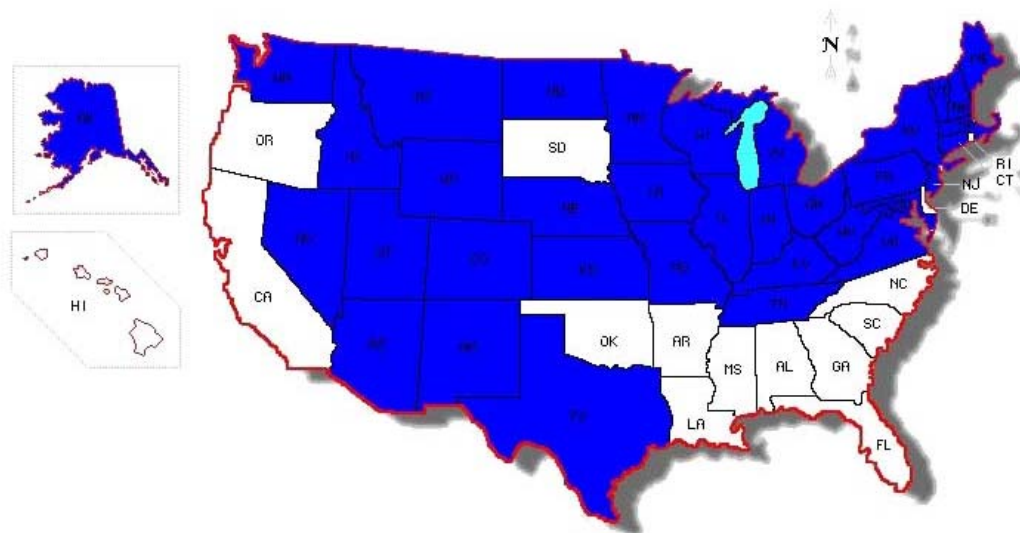
Lee Smithson, the Coordinator of the Snow and Ice Pooled Fund Cooperative Program under AASHTO.

While the idea to hold the Peer Exchange came first, “the timing of the planned Peer Exchange seemed to dovetail very nicely with the Eastern Snow Expo and AASHTO was gracious enough to suggest a tie-in,” said Burkheimer.

“This allowed attendees to the Peer Exchange the opportunity to extend their stay to attend the one-day Eastern Snow Expo. It also worked nicely that vendors were able to participate in the last day of the Peer Exchange to hear the problems of the states in attendance, and the attendees of the Peer Exchange were given one-on-one time with vendors before the doors to the Eastern Snow Expo were opened. Both groups benefited,” he said.

To bridge the communication gap between research organizations and states, organizers invited up to two representatives from the departments of transportation in every state, with sponsoring organizations picking up the cost of travel and lodging. In the end, 35 states and the District of Columbia were represented. The two-day event featured a variety of forums designed to identify the most critical issues in winter maintenance.

“For the first time it brought all of the players together to share information and network on snow- and ice-related issues,” said co-chair Diana Clonch. “It brought the professional organizations, the decision makers from 35 states across the U.S. and D.C., and industry together for collective decision making.”



**Figure 1: States Represented**

Source: Diana Clonch



The event opened with presentations by a number of the partner agencies. Representatives from Clear Roads, Aurora, PNS, FHWA, and SICOP shared findings from their latest winter maintenance research and initiatives, such as Road Weather Information Systems, evaluation of anti-icing and deicing products, Ground Speed Control systems, Maintenance Decision Support Systems and Clarus.

The core of the conference was a series of round table discussions, the topics for which grew out of a survey in which the states were asked to list their most critical winter maintenance challenges. Responses to the survey were compiled and reviewed by the conference steering committee, and a plan was developed to organize the round table discussions around four tracks intended to address those challenges. Moderators from the Western Transportation Institute and facilitators from state and federal transportation agencies helped to lead the discussions and document the exchange of ideas.

“For researchers, it was a great opportunity to hear specific, detailed ideas from the states about what kind of research would help them the most in their day-to-day operations,” said Dr. Xianming Shi, the WTI Winter Maintenance and Effects Program Manager who served as one of the moderators.

On the second day, participants voted on the research needs that they believed were most important to their state maintenance operations. In the final session, they had the chance to comment on the results of the voting and on suggested next steps. Because these were true winter maintenance practitioners, it was hoped that a high level of confidence could be placed on the validity of the problem statements that resulted from the session as the most important issues facing the snow and ice community.

In another unique aspect of this conference, vendors were invited to participate in the discussion, so they could hear firsthand some of the problems that practitioners are facing. Industry representatives also provided valuable information of their own. “One of the problems identified by attendees was the lack of a standard protocol for communication between components in the cab and the garage using GPS/AVL technology,” noted Burkheimer. “One of the vendors was able to point out that Europe was working on a communication standard that would solve our problem. He later sent the draft version of the European Standards.”

Response to the event was enthusiastic and positive. Together the participants identified and prioritized 70 research problem statements. Organizers continue to work on them, looking for opportunities to consolidate or refine the issues.

The conference also helped participants build personal relationships with others in their field. “The most important thing you can do at an event like this is to establish a network with your peers,” said Clonch, “so when you need something, you know exactly who to turn to.”

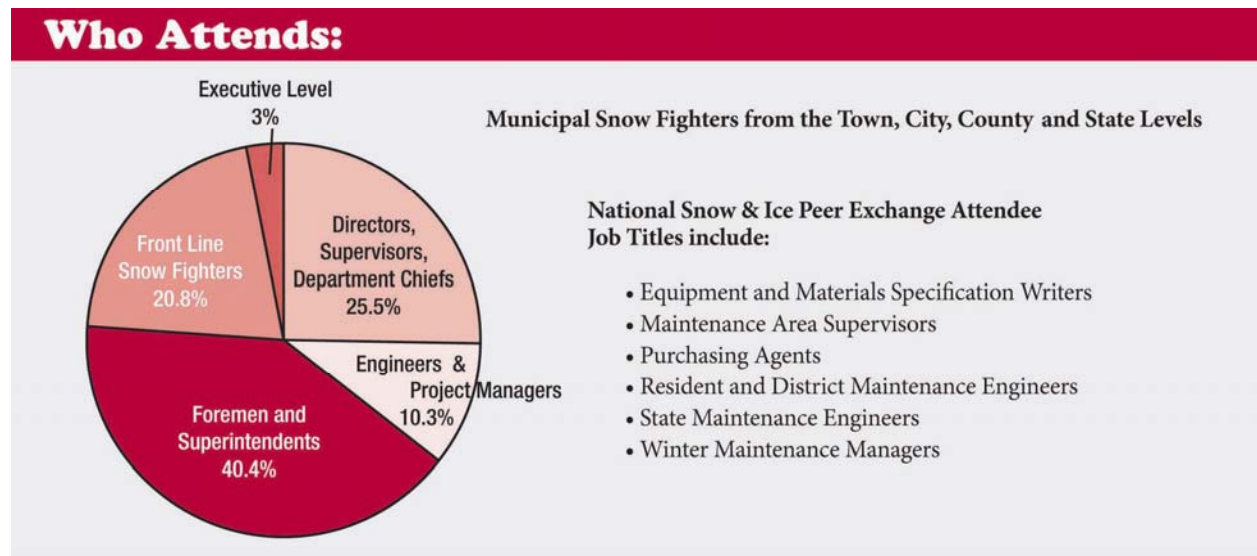


Figure 2: Attendees, by job title

Source: adapted from conference brochure

Perhaps the clearest indicator of success is that many of the participants would like to make the conference an annual event. “One and a half days was almost too short,” said Tina Greenfield, representing the Aurora research consortium, and one of the steering committee members. “There was just so much to talk about. The venue was great and it naturally flowed into the Eastern Snow Show.”

For the next winter maintenance peer exchange, Greenfield recommended “having more discussion time ... so states could share more of their ideas and people can see more of what's going on around the nation.”

The following sections give further details on the background and development of the peer exchange. Section 2 details the groups actively involved in winter maintenance research issues who were instrumental in conducting the peer exchange. The process for creating the event agenda, including the method for defining round table discussion topics, is described in Section 3. The prioritization of research needs that came out of the peer exchange is outlined in Section 4. At the end of the event, attendees were asked to complete a questionnaire on the strengths and weaknesses of the programs and suggestions for the future. The results can be found in Section 5. The steering committee’s recommendations are described in Section 6. A complete attendee list is attached as Appendix A, and a summary of the discussion tracks is included as Appendix B.

## 2. BACKGROUND INFORMATION ON RESEARCH CONSORTIUMS

### 2.1. American Association of State Highway and Transportation Officials (AASHTO)

The American Association of State Highway and Transportation Officials (AASHTO) is a nonprofit, nonpartisan association representing highway and transportation departments in the 50 states, the District of Columbia, and Puerto Rico. It represents all five transportation modes: air, highways, public transportation, rail, and water. Its primary goal is to foster the development, operation, and maintenance of an integrated national transportation system. AASHTO is the voice for transportation and catalyst for organizational and technical excellence. It advocates transportation-related policies and provides technical services to support states in their efforts to efficiently and safely move people and goods. (<http://www.transportation.org/>)



### 2.2. Aurora

Aurora is an international program of collaborative research, development and deployment in the field of road and weather information systems (RWIS), serving the interests and needs of public agencies. The program, launched in 1996, brings together a number of U.S., Canadian, and European agencies. The Aurora vision is to deploy RWIS to integrate state-of-the-art road and weather forecasting technologies with coordinated, multi-agency weather monitoring infrastructures. It is hoped this will facilitate advanced road condition and weather monitoring and forecasting capabilities for efficient highway maintenance, and the provision of real-time information to travelers. Aurora's initiatives are conducted and funded by member agencies, for member agencies. Three times a year, Aurora members meet to set the agenda for RWIS research. Selected initiatives are led by "champion" member agencies, managed by committees of Aurora members, and funded out of the Aurora pooled fund. Through these meetings and monthly teleconferences, members keep informed about progress on Aurora initiatives and other RWIS-related activities around the world, share their agencies' accomplishments, and learn solutions for common in-the-field problems. Because current members include international leaders in RWIS research, technology, and deployment, many of whom are also affiliated with AASHTO's Snow and Ice Cooperative Program (SICOP) and other RWIS-related programs, the breadth and quality of information exchanged at these meetings is invaluable. (<http://www.aurora-program.org/>)



### 2.3. Clear Roads

The Clear Roads pooled fund project began in early 2004 in response to a need for real-world testing in the field of winter highway operations. This ongoing project led by the Wisconsin Department of Transportation has attracted 14 member states and is funding practical, usable winter maintenance research aimed at rigorous testing of winter maintenance materials, equipment and methods for use by highway maintenance crews. By conducting structured field testing and evaluation across a range of winter conditions and highway maintenance organizational structures, Clear Roads projects delivers immediately useful data and recommendations on the effectiveness, ease of use, optimum application rates, durability, and more, of many advanced winter operations technologies. (<http://www.clearroads.org/>)



### 2.4. Pacific Northwest Snowfighters (PNS) Association

Transportation agencies within the states of Washington, Oregon, Montana and Idaho and the province of British Columbia formed a committee several years ago to develop specifications for chemicals related to snow and ice control. This committee has evolved to become the Pacific Northwest Snowfighters (PNS) Association. The PNS strives to serve the traveling public by evaluating and establishing specifications for products used in winter maintenance that emphasize safety, environmental preservation, infrastructure protection, cost-effectiveness and performance. The association is comprised of technical experts in the fields of chemistry, environment, maintenance operations and management, insurance law and claims, public affairs and purchasing. The association has been privileged to work with the foremost pioneers in deicing technology. The mission of the PNS is to provide specifications for the highest quality products balancing quality of environment with providing the safest possible transportation system and maximum mobility for the traveling public during snow and ice conditions, within reasonable budgetary, product performance and environmental constraints. By consolidating the resources and purchasing power of the member agencies, the association anticipates that the quality and cost of these products will become more favorable and are considering the challenges and feasibility of developing a contract for use by the entire PNS membership. (<http://www.wsdot.wa.gov/partners/pns/default.htm>)



## **2.5. Snow and Ice Pooled Fund Cooperative Program (SICOP)**

SICOP, the Snow and Ice Pooled Fund Cooperative Program, is a Winter Maintenance Technical Service Program (WMTSP) developed by AASHTO (American Association of State Highway and Transportation Officials). A principal mission of the Winter Maintenance Program (WMP) is to ensure that the requisite testing and evaluation of potentially implementable international or domestic winter maintenance technologies are performed and that the results of these efforts are presented and disseminated in such a manner that modern winter maintenance technologies are easily understood and integrated into individual state and municipal operational programs. Beyond this principal mission, the WMP works toward establishing a systems approach to snow and ice control in the United States—one involving the vehicle, the driver, and the equipment, the materials and practices—for managing roadway and bridge snow and ice. The goals of the proposed WMP are to (1) sustain or improve levels of winter maintenance service with significant benefit/cost improvements, (2) provide an enhanced level of environmental protection, and (3) place technology in service on operational maintenance sections within two winter seasons. The concept of funding is unique in that all funding will be via a pooled funding mechanism. (<http://www.sicop.net>)

### 3. PEER EXCHANGE AGENDA

## National Winter Maintenance Peer Exchange Conference Agenda Crown Plaza, Columbus, Ohio August 28-29, 2007

### Tuesday, August 28, 2007

- 7:00 am to 8:00 am Registration
- 7:30 am to 8:00 am Continental Breakfast
- 8:00 am to 8:15 am Welcome and Purpose of Exchange- Diana Clonch
- 8:15 am to 8:45 am Aurora- Updates on research projects for this pooled fund group in Roadway Weather Information Systems (RWIS) and Surface Transportation Weather- Tina Greenfield (Iowa DOT)
- 8:45 am to 9:15 am Clear Roads- Updates on research projects for this pooled fund group on materials, methods and equipment used in winter maintenance- Dennis Belter (Indiana DOT)
- 9:15 am to 9:45 am Pacific Northwest States (PNS)- Updates on research projects by this group to evaluate and establish specifications for products used in winter maintenance. - Ron Wright (Idaho Transportation Department)
- 9:45 am to 10:15 am Break
- 10:15 am to 11:00 am FHWA- Update on the Maintenance Decision Support System (MDSS), Clarus and other surface transportation weather projects- Pat Kennedy (FHWA)
- 11:00 am to 11:30 am SICOP/TRB- Updates from the Snow and Ice Cooperative Program and the Transportation Research Board on winter maintenance research efforts – Lee Smithson (AASHTO)

11:30 am to noon National Winter Driving Safety Initiative- A national winter driver safety campaign was developed over the past year. See and hear how the program can be used in all states to encourage safe winter driving- Dennis Burkheimer (Iowa DOT)

Noon to 1:15 pm Lunch

1:15 pm to 2:15 pm Round Table Discussions- Key snow and Ice removal issues will be identified through the survey of attendee states for in-depth discussion in small groups. The round table discussions will help identify the research needs in the future

2:15 pm to 3:00 pm Break

3:00 pm to 4:00 pm Round Table Discussions continued

4:00 pm Day 1 wrap-up

**Wednesday, August 29, 2007**

- 7:30 am to 8:00 am Continental Breakfast
- 8:00 am to 10:00 am Round Table Discussion continued.
- 10:00 am to 10:30 am Break
- 10:30 am to 11:30 am Round Table presentations- Leaders from each round table discussion will be asked to make a presentation on the key research needs revealed in the discussions Break
- 11:30 am to noon Vote on Research needs- Each attendee will be given the ability to vote on the research needs identified in the round table discussions that they feel are most important for their state or operations
- Noon to 1:30 pm Lunch with Vendors
- 1:30 pm to 2:30 pm Results of the morning vote on problem statements and research needs for winter snow and ice removal operations (vendors will also participate in the discussion)
- 2:30 pm to 3:00 pm Wrap-up and next step – Lee Smithson (AASHTO); Survey of attendees
- 3:00 pm to 4:30 pm Open time in vendor area of the Eastern Snow Expo for one-on-one discussions



### 3.1. Development of Tracks

In order to focus the peer exchange discussions, a preliminary survey was sent to the state DOTs, along with invitations to attend, to determine the most pressing needs and challenges seen by each state. Tina M. Greenfield, Road Weather Information Systems (RWIS) Coordinator for the Iowa DOT and member of the peer exchange steering committee, grouped the survey responses and four discussion tracks were developed.

#### 3.1.1. DOT Survey Letter

### National Winter Maintenance Peer Exchange Survey Questions

1. How many representatives from your state do you plan to send to the National Peer Exchange?  
Circle response: none          one          two
2. Please submit the names and contact information below for your state representatives below:

Attendee 1 Name \_\_\_\_\_

Title: \_\_\_\_\_

Mailing address \_\_\_\_\_

Phone number \_\_\_\_\_

e-mail address \_\_\_\_\_

Attendee 2 Name \_\_\_\_\_

Title: \_\_\_\_\_

Mailing address \_\_\_\_\_

Phone number \_\_\_\_\_

e-mail address \_\_\_\_\_

If space is available, how many additional representatives would you like to send from your state at your own cost? \_\_\_\_\_

3. Check the title(s) that best describes the attendees position within the state:  
\_\_\_\_ Researcher  
\_\_\_\_ Practitioner

- \_\_\_\_\_ Combined Researcher and Practitioner
- \_\_\_\_\_ State Maintenance Engineer or Manager
- \_\_\_\_\_ RWIS Coordinator or related position
- \_\_\_\_\_ Winter Operations Administration
- \_\_\_\_\_ Other (please describe) \_\_\_\_\_

4. What are some new and/or innovative features of your winter maintenance program you would like to share with other state? \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

5. Would a representative from your state be willing to make a 15-20 minute presentation on your winter maintenance program? \_\_\_\_\_

6. If you answered yes to question 5, please provide the name of the presenter:

\_\_\_\_\_

7. Please list the top three winter maintenance problems or challenges faced by your state.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

### 3.1.2. Survey Responses

#### Winter Maintenance Peer Exchange Survey Results - Ideas/Presenters/Challenges

DOT	Ideas to share	Potential presenter	Winter maintenance challenges
Alaska			-Staffing levels -Keep road friction at safe level during temperature fluctuations -Public opposition to chemicals
Arizona	-Experience with our training simulators		-Training -Staffing levels -Resources
Connecticut	Connecticut has just gone over to a liquid calcium chloride product and have almost eliminated the use of sand.  A five minute presentation may be provided on our new use of Calcium Chloride and what went well and what did not this season.	Cosmo Ignoto or Philip Zoppi or the two together	-Funding and manpower -Aging equipment for snow & ice control -Environmental concerns in the constraints placed upon our Department in relation to experimenting with new and innovative products for snow & ice control.
Idaho	-Just in time liquid applications -Inhibitors for salt brines -Reduction on antiskid use	Brent Jennings	-State growth and service -Cost effectiveness of a corrosion inhibited program -Financing the level of service
Illinois	-Experimentation with Ag byproducts such as Ice Ban and Geomelt -The use of increased amount of prewet liquids up to 57 gal/ton -Joystick controls -Installation of brine making systems capable of blending multiple chemicals -Dual spinners	Dean Kernan	-Training -Collection and evaluation of winter data -Consistent use of chemicals and plowing techniques
Indiana	-Safe Lane Performance -AVL Project	Tom Konieczny	-Manpower for Winter Maintenance -Additional infrastructure and lane mile additions. How to cover? -Best application rates for conditions and proper materials and applications
Iowa	-Multiple blade plow system -Winter training program - modular system -Liquid deicer program	Tina Greenfield	-Training and information to and from equipment operators -Communication of best practices to other garages in the state, uniform -Public expectations -Deicer
Kansas	-MDSS		-Forecast accuracy

DOT	Ideas to share	Potential presenter	Winter maintenance challenges
Kentucky	-Anti-icing Practices and Procedures -Outsourcing - Practices and Procedures -RWIS System - Developed In-House -Emergency Salt Stockpile Procedures	-David Cornett -Michael Williams	-Monitoring contractors -Predicting the start of a winter storm -Scheduling manpower during an extended storm event -Lack of Adequate Maintenance Personnel -Growing Concern of Environmental Impacts -Weather and Pavement Forecasting
Maine	-WiFi data download from ground speed control -Working with NWS	-Brian Burne -Cliff Curtis	-Balancing safety/cost/environmental issues -Getting people to slow down during inclement weather -Quantifying winter severity from one year to the next
Maryland	Not at this time		-Lessening salt usage -Improving measurement of performance -Implementing MDSS
Michigan		Tim Croze	-Level of service consistency along a corridor -Lots of inexperienced operators due to retirements
Minnesota	-Winter Performance Measures (Bare Lane, Omnibus and Trade-off studies) -Maintenance Training (SPOT, simulator, environmental training & core training) -Winter Pilot Projects - reducing application rates, Metropolitan Winter Operations, Anti-icing Program, and AVL Efforts	-Linda Taylor - Maint. Training -Steven Lund - Winter Perf. Measures -Linda/Steven - Winter Pilot Projects -Norm Ashfeld - Metro Winter Ops or AVL efforts	-Staffing - retention and training (seasonal, temporary and program delivery workers) -Equipment funding and utilization -Implanting strategies statewide (i.e. Anti-icing, applications rates)
Missouri	-One pass clearing using 14' wide snowplows and TowPlows	Bob Lannert	-Having to clear more lane miles with the same or less numbers of people and equipment -Need optimum snowplow designs for high speed plowing and for fuel economy
Montana	Equipment features, truck calibrations and what we are doing in Montana to reduce abrasives	Randy Roth	-Funding -Manpower -Inaccurate weather forecasts
Nebraska	-Snowplow Management with AVL -Non-contact friction sensor for FAST activation	Michael Mattison	-Personnel/Equipment requirements for severe long duration events -Training of proper techniques -Availability of salt throughout the winter

DOT	Ideas to share	Potential presenter	Winter maintenance challenges
Nevada		Bill Hoffman	<ul style="list-style-type: none"> <li>-Effective and efficient decision making</li> <li>-Feedback to maintenance crews regarding performance</li> <li>-Chemical impacts on the environment</li> </ul>
New Jersey			<ul style="list-style-type: none"> <li>-Knowing when to efficiently and effectively deploy</li> <li>-Keeping roads clear with minimal resources</li> <li>-Keeping in-house, contract &amp; amp; volunteer staff trained in winter maintenance</li> </ul>
New Hampshire	I-93 salt brine program	Douglas Graham	<ul style="list-style-type: none"> <li>-Demand by public for bare pavement</li> <li>-Cost of materials</li> <li>-Ability to hire and/or retain employees due to low wages</li> </ul>
New York	<ul style="list-style-type: none"> <li>-Progressing the use of AVL in conjunction with moss</li> <li>-Equipment Operator Training Program</li> </ul>	<ul style="list-style-type: none"> <li>-Michael Lashmet or</li> <li>-Robert Selover</li> </ul>	<ul style="list-style-type: none"> <li>-Developing snow and ice performance measures; rating level of service during storms</li> <li>-Budgetary constraints related to hiring personnel</li> <li>-Encouraging use of anti-icing statewide (currently limited areas)</li> </ul>
Rhode Island	<ul style="list-style-type: none"> <li>-All snow plow routes were digitized and placed in State of Rhode Island's GIS map system</li> <li>-Microsoft Excel workbooks were developed for reporting working times for hired snow vendors</li> <li>-Microsoft Excel workbooks were developed for reporting an estimated cost for each winter maintenance operation</li> <li>-RIDOT has developed a "Web Application" to help manage winter storm data</li> </ul>		<ul style="list-style-type: none"> <li>-Weather forecasts for accurate starting and ending times for winter storms</li> <li>-Correct application rates of de-icing chemicals during winter maintenance operations</li> <li>-Obtaining funding for new technologies that are proven to work or help in winter storm operations</li> </ul>
Tennessee	-Newest innovation (not very new) is anti-icing. A successful program. Looking at porous pavement overlays.	Will decide at a later date if they are presenting.	<ul style="list-style-type: none"> <li>-Freezing rain</li> <li>-Rain prior to frozen precipitation</li> <li>-Missed forecasts</li> </ul>
Texas	Texas is currently working toward more advanced materials and equipment packages. We are interested in learning more to help our program.	None	<ul style="list-style-type: none"> <li>-Managing budget constraints</li> <li>-Traveler expectations</li> <li>-Long haul truckers</li> </ul>

DOT	Ideas to share	Potential presenter	Winter maintenance challenges
Utah	<ul style="list-style-type: none"> <li>-Wing plow laser guidance systems</li> <li>-Fog dispersal</li> <li>-Plow Driver Simulator training</li> <li>-Stainless steel spreader boxes</li> <li>-RWIS communications</li> </ul>	Lynn Bernhard	<ul style="list-style-type: none"> <li>-Road condition data gathering and reporting</li> <li>-Re-freeze of treated pavements</li> <li>-Drifting snow</li> <li>-Managing brine concentration on the road to prevent refreeze</li> <li>-Predicting and warning for intense storms in limited areas</li> <li>-Salt application rates</li> </ul>
Vermont	Use of brine (District 5) for anti-icing	None	<ul style="list-style-type: none"> <li>-Staffing shortages - essentially 1 person per piece of equipment</li> <li>-Budget issues and timing of our state fiscal year - planning problems</li> <li>-Facility locations and route lengths (rural) cause timing issues</li> </ul>
Virginia			
Washington DC			<ul style="list-style-type: none"> <li>-Volume of traffic affects on pre-treatments</li> </ul>
Washington State	<ul style="list-style-type: none"> <li>-Challenges of snow and ice operations in Washington's different climatic zones.</li> <li>-Avalanche control operations on the passes in the Washington Cascade's.</li> <li>-Recent experiments with solid anti-icer.</li> </ul>	<ul style="list-style-type: none"> <li>-Monty Mills</li> <li>-Tom Root</li> </ul>	<ul style="list-style-type: none"> <li>-Accomplishing level of service expectations under current budget constraints.</li> <li>-Tort liability.</li> <li>-Accurate data collections and reporting in winter operations.</li> </ul>
Wyoming			<ul style="list-style-type: none"> <li>-Blowing snow/limited visibility</li> <li>-Lack of experienced workforce</li> <li>-Ice</li> </ul>

## **3.2. Round Table Discussions**

Conference organizers reviewed the survey results and organized the stated challenges from the respondents into four areas, corresponding to the following tracks. Proposed discussion questions and background information on state efforts to address these concerns can be found in Appendix B.

### **3.2.1. Track 1: Increasing Expectations, Performance Measures and Environmental Impacts**

#### **Increasing expectations**

- State growth and service
- Financing the level of service
- Manpower for winter maintenance
- How to cover additional infrastructure and lane-mile additions.
- Public expectations: Having to clear more lane miles with the same or fewer number of people and equipment
- Accomplishing level of service expectations under current budget constraints

#### **Performance measures**

- Quantifying winter severity from one year to the next
- Improving measurement of performance
- Developing snow and ice performance measures
- Rating level of service during storms

#### **Environmental Impacts**

- Public opposition to chemicals
- Growing concern of environmental impacts
- Chemical impacts on the environment

### **3.2.2. Track 2: Decision Making Skills, Dealing with Refreeze and Equipment**

#### **Decision-making skills**

- Best application rates for conditions and proper materials and applications
- Reducing salt usage
- Correct application rates of de-icing chemicals during winter maintenance operations
- Salt application rates
- Effective and efficient decision making regarding de-icers
- Knowing when to efficiently and effectively deploy

- Keeping roads clear with minimal resources

### **Dealing with refreeze**

- Keep road friction at safe level during temperature fluctuations
- Refreeze of treated pavements
- Managing brine concentration on the road to prevent refreeze

### **Equipment**

- Equipment funding and utilization
- Need for optimum snowplow designs for high-speed plowing and for fuel economy

## 3.2.3. Track 3: Staffing Issues, Training Challenges and Communicating to the Crews

### **Staffing issues**

- Scheduling manpower during an extended storm event
- Lack of adequate maintenance personnel
- Lots of inexperienced operators due to retirements
- Staffing: retention and training (seasonal, temporary and program delivery workers)
- Personnel/equipment requirements for severe, long-duration events
- Budgetary constraints related to hiring personnel
- Staffing levels

### **Training Challenges**

- Training and information to and from equipment operators
- Training of proper techniques
- Keeping in-house, contract and temporary personnel
- Volunteer staff trained in winter maintenance

### **Communicating to Crews**

- Feedback to maintenance crews regarding performance
- Communication of best practices to other garages in the state

## 3.2.4. Track 4: Weather and Forecasting, Consistency and Data Collection

### **Weather and Forecasting**

- Predicting the start of a winter storm
- Weather and pavement forecasting
- Implementing FHWA's Maintenance Decision Support System program



- Weather forecasts for accurate starting and ending times for winter storms
- Freezing rain
- Rain prior to frozen precipitation
- Missed forecasts
- Drifting snow
- Predicting and warning for intense storms in limited areas

#### **Consistency**

- Consistent use of chemicals and plowing techniques
- Level of service consistency along a corridor
- Implementing strategies statewide (e.g., anti-icing, applications rates)
- Uniformity
- Encouraging use of anti-icing statewide (currently limited areas)

#### **Data Collection**

- Collection and evaluation of winter data
- Accurate data collections and reporting in winter operations
- Road condition data gathering and reporting

### **3.3. Selection of Facilitators and Moderators**

The four round table discussions were directed by moderators from the Western Transportation Institute, and facilitators from various DOTs, research agencies and organizations who were members of the Peer Exchange steering committee. Facilitators led off the discussions with a brief summary of activities in their state relative to the track theme. The WTI staff moderators then got the discussion started using information from the facilitator's presentation as well as discussion questions that had been generated for each track in the initial survey to state DOTs. Moderators were responsible for keeping the discussion on track. Facilitators were responsible for drilling down and refining the details so the research need could be stated as succinctly as possible.

#### **3.3.1. Facilitators and Moderators**

##### **Track 1: Increasing Expectations, Performance Measures and Environmental Impacts**

- Linda Taylor, Maintenance Research and Training Engineer, Minnesota DOT
- Ron Wright, Chemistry Laboratory operations manager, Idaho Division of Highways
- Dan Williams, WTI research staff, formerly with Montana DOT (moderator)

##### **Track 2: Decision Making Skills, Dealing with Refreeze and Equipment**

- Dennis Burkheimer, Winter Operations Administrator, Iowa DOT
- Tom Root, Assistant State Maintenance Engineer, Washington State DOT
- Xianming Shi, WTI Program Manager, Winter Maintenance and Effects (moderator)

### **Track 3: Staffing Issues, Training Challenges and Communicating to the Crews**

- Diana Clonch, Snow and Ice Coordinator within the Office of Maintenance, Ohio DOT
- Lee Smithson, Snow and Ice Cooperative Program (SICOP) Coordinator for the American Association of State Highway and Transportation Officials (AASHTO)
- Eli Cuelho, WTI Program Manager, Infrastructure Maintenance and Materials (moderator)

### **Track 4: Weather and Forecasting, Consistency and Data Collection**

- Dennis Belter, Maintenance Administration Manager, Indiana DOT
- Tina Greenfield, Road Weather Information Systems (RWIS) Coordinator, Iowa DOT
- Chris Strong, WTI Program Manager, Safety and Operations (moderator)

## **3.4. Round Table Discussion Results**

Each track of the round table discussion was conducted twice—once on each day of the conference—so attendees could participate in more than one, and so each state sending two representatives could attend all the discussions. At each session, a list of research needs was identified. There was no limit on the number to be considered, but after the sessions, staff members assisted moderators and facilitators in combining and refining the lists to provide clarity and reduce any duplication.

A final list of 70 choices was compiled on an unranked ballot. Each participant was given 20 votes to use as they wished, but they could not apply more than five votes to one identified need. The results were tabulated and presented at a final discussion session at the end of the second day. Laura Fay, a WTI researcher who assisted in the ballot compilation, suggested it would be a good idea at the next Peer Exchange to allot more time to the process. “We could have used more time to hone the ideas better, making sure there’s no overlap,” she said. That idea was echoed in the conference evaluations (see Section 5). She said it was difficult to go from 70 ideas to five while making sure to maintain the intent of those who voted on the topics. “Maybe you can make the ideas bigger and incorporate more in them,” she said. Nonetheless, she said the conference was successful at accomplishing what it was intended to do. “We did identify research needs. We did identify champions for those ideas. We got input from vendors,” she said.

#### 4. REFINEMENT OF RESEARCH NEEDS GENERATED AT ROUND TABLE DISCUSSIONS

At the conclusion of the peer exchange, the following ranked 70 research priorities were handed off to the steering committee for further refinement.

Rank	Research Needs Statement	Vote Tally	Champion
1	How to determine the proper timing and frequency of anti-icing and deicing?	72	Xianming Shi, WTI
2	Develop an anti-icing, de-icing and pre-wetting implementation guidelines	62	Paul Brown MASS/Clear Roads
3	Synthesis of Unconventional Staffing Strategies to Meet Increasing Demands	61	
4	Develop standardized performance measure for snow & ice.	59	Xianming Shi, WTI
5	Are the FHWA TE-28 anti-icing guidelines accurate, appropriate and effective?	57	Xianming Shi, WTI, John Clarke, Ohio
6	Identify long- term impacts of not funding maintenance fully for summer and winter activities.	43	Cosmo Ignoto, CT DOT
7	Improvements in sensing and forecasting of ice, freezing rain and frost conditions	42	
8	Determine staffing and funding for core maintenance activities.	40	David Ray, Ohio
9	Develop tools to manage and communicate LOS, expectations, and costs associated to urban, sub-urban and rural routes	39	Brad Darr, ND DOT David Ray, Ohio
10	Build a test facility to provide objective data regarding the effectiveness of various winter maintenance treatments	37	Tina Greenfield, Dennis Burkheimer, Iowa, Eli Cuelho, WTI
11	Developing the next generation concept vehicle and optimized plow design	36	John Clarke, Ohio
12	Seamless wireless communication for transferring data from vehicle to maintenance garage	35	Brent Jennings, Idaho
13	Is there a defensive way to determine or establish LOS nationwide (corridor management and seamless LOS across state boundaries).	34	Allen Williams, UDOT
14	Best way to measure the chloride content on the surface and determine how long they last	34	
15	Support more meetings for peer exchange, similar to this one	34	
16	Cost-benefit analysis of winter maintenance equipment purchases and upgrades	33	
17	Develop on-vehicle salinity sensor	33	
18	The Importance of Post-Storm Meetings	32	David Ray, Ohio
19	Determining an Appropriate Wintertime LOS for Specific Areas	30	

Rank	Research Needs Statement	Vote Tally	Champion
20	Better use of RWIS and weather forecasts for decision making	28	
21	Best Practices in winter maintenance performance (e.g. post storm assessment)	27	
22	Synthesis of best practices for reducing corrosion on winter maintenance equipment	27	David Ray, Ohio
23	Synthesis of Strategies for Retaining Trained Personnel	27	Brent Jennings, Idaho
24	How to we establish appropriate dedicated funding levels for maintenance	26	
25	Investigate alternative blade inserts	26	Lynn Bernhard, UDOT
26	Developing improved precipitation sensor	26	
27	Pilot evaluation of virtual pavement sensors and on-board friction devices	25	Eli Cuelho, WTI
28	State-of-the-Practice for Using Driver Simulators as a Training Tool	25	Steve Lund, MnDOT
29	Development of standards for in-vehicle equipment	25	Dennis Burkheimer, Iowa Chris Strong, WTI
30	Can chemical blends cause slippery and refreezing?	22	
31	Optimizing the ergonomics for snowplow operators	22	
32	Develop standard ratings and descriptors for road conditions	22	Philip Anderle, CDOT
33	Develop acceptable dynamic messages for snow and ice.	21	
34	Develop standard specifications for components and communications	21	John Clarke, Ohio
35	Developing Tools for Outreach	21	Jim Cota, Vermont DOT
36	Develop a state winter severity index as a tool to compare materials use and costs (Mn/DOT, WashingtonDOT, New Hampshire)	20	Chris Strong, WTI
37	How to most effectively communicate performance measures and associated costs to internal staff, operators and stakeholders.	19	
38	Need a tool to provide or ensure funding is available to cover salt/sand stockpiles and secondary containment for liquids.	19	
39	Training for how to use technologies (e.g. RWIS, in-vehicle pavement sensors)	19	
40	Road prioritization formula for winter maintenance LOS	18	
41	Best Practices for Balancing Politics and Performance	18	

Rank	Research Needs Statement	Vote Tally	Champion
42	Is there a defensive way to determine or establish LOS nationwide (corridor management and seamless LOS across state boundaries).	17	
43	Inform stakeholders of the critical activities and impacts of maintenance on daily lives.	17	
44	Investigate what factors influence refreezing on the road	17	Xianming Shi, WTI, Eli Cuelho, WTI
45	Investigate collision avoidance systems for snowplows	17	
46	Explore use of highly detailed satellite imagery in winter maintenance operations	17	Mike Mattison, Nebraska
47	Training for maintenance personnel to interpret forecasts	16	
48	Meeting Increasing Training Challenges	15	
49	Optimization of the in-vehicle driver interface	13	
50	Synthesis how to effectively relay and communicate winter maintenance budget is needs to upper management and legislatures.	12	
51	Standardized tests for winter maintenance equipments	12	
52	Improved chemical sensor	12	
53	Developing Methodologies for Evaluating Training Efforts	10	
54	Developing measures of forecast accuracy	10	
55	Develop guidelines for BMPS to achieve attainment in areas of concern	9	Jim Cota, Vermont DOT
56	Educating meteorological community about the maintenance personnel's weather information needs	9	
57	Pursue objective testing to verify the effectiveness of innovative maintenance treatments	9	
58	Establish seamless boundaries for winter information across states.	8	
59	Feedback of customers expectation on winter maintenance	8	
60	Can the road surface refreeze due to over application of salt?	8	
61	Improvements in forecasting of low-elevation weather conditions	8	
62	Innovative Solutions for Real-Time Vehicle-to-Center Data Communications	8	
63	Develop plan for improving weather forecasts through outreach to meteorological community	7	
64	FHWA develop pilot /demonstration projects for seamless winter operations (NCHRP 20-74A problem statement).	5	
65	Synthesis of Methods to Compete with Industry	5	

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Rank	Research Needs Statement	Vote Tally	Champion
66	What is the true cost of a data collection system (e.g. AVL)?	5	
67	Case Studies on Ensuring Consistency in Winter Maintenance Practice Across State Borders	5	
68	Boilerplate Language for Data Sharing	4	
69	Education about Microclimates	2	
70	Best practices for snow fences	2	
		1604	

The Steering Committee reviewed the 70 research needs statements and decided the list needed to be consolidated by grouping similar statements, but retaining the original wording to insure the intent of each statement was maintained throughout the consolidation process. The consolidated list would then be sent to the research consortiums for their consideration for inclusion in their future research programs.

## 5. ATTENDEE SURVEY RESULTS

### 5.1. Attendee Comments

Attendees seemed very pleased with this, the first such Peer Exchange on winter road maintenance. To read the 84 evaluation forms left by the attendees makes it clear that practitioners in the winter maintenance field felt a real need for this kind of event. Ninety-four percent said they would be interested in attending a future meeting.

Many offered their thanks to the organizers for bringing everyone together for the exchange. “I’d like to congratulate you and thank you for an enjoyable and productive meeting. Research directions that came from this are icing on the cake,” said one participant. “Your attendees leave better informed and better connected as well as reinvigorated.”

Some expressed gratitude for the “excellent cross-section of agencies and groups” represented, calling it a “great opportunit[y] to network and share experiences and discuss challenges.” Others said they especially appreciated having vendors available to join the discussions. “This was a great idea, ranks right at the top of my list of conferences I’ve attended over 35 years in the business,” wrote one attendee.

The most common complaints decried the brief time allotted for the meeting:

- *More time* to discuss what each state is doing
- *More time* to exchange ideas, discuss problems and successes
- *More exchange* of information between states
- *More info sharing*
- *More time to exchange information* on state best practices
- *More time for round table discussion* open exchange
- *More time to discuss* practices
- *More time* allotted for DOT’s *to interact*
- *More time* to discuss topics
- *Need more time* for round table
- *Would like more time* for talk about how or what each state handles or does winter maintenance in a meeting setting
- Would like to have *more time* in a topic area, seemed like we were just getting warmed up in some areas when it was “time’s up”
- This was a great meeting. *The only improvement would be to have more discussion* with peers on problems and solutions
- Let the group *go for at least a 4-hour block. Go three days if need be.*

More specific recommendations suggested a need to better define problem areas and research needs. A few seemed overwhelmed by the array of suggested discussion topics. Some felt the ballot on research focus areas contained too much overlap and said that more should be done to clarify the issues before being asked to vote on them:

- You might define discussion areas more the next time
- More problem statements derived from the group prior to another event
- Review of states winter operation policies. Share that information prior to the next conference, so more detailed discussion can take place
- The breakout sessions topics were very broad/inclusive. Should narrow down to a fewer number of specific items
- Several of the topics that were voted on are already being addressed in other research. Someone needs to do a literature search to make sure that we are not reinventing the wheel
- Roundtables – professional facilitator that keeps group on track, records results, consolidates results. Budget tie to eliminate duplication in statement prior to voting
- Maybe figure out better way to group/eliminate overlaps for voting process.

Many expressed appreciation for the scheduling of the conference with the Eastern Snow Expo, and said that format should continue in the future, with even more input from the Expo vendors:

- Maybe we could ask vendors or others what they'd like to see addressed
- Give exhibitors three minutes to showcase their products that will be displayed at the show. Basically a sales pitch for the exhibitors to perk interest
- Maybe have a PowerPoint slide show running between break out sessions so attendees can get a chance to see who the exhibitors are
- Get some vendors to speak, as long as they are generic/non self promoting of their products, and speak about products/applications/concepts from their point of view
- Vendor presentation on value topics
- How do vendors get involved? What steps will be taken to involve vendors in product development?
- Excellent process and getting [vendors] involved
- Having a couple of vendors to present on what they can do in relation to some of the equipment and technology.



**5.2. Attendee Evaluation Form Results**

**1. Ability to actively participate in discussions and have my research needs considered**

Question #	Poor 1	2	Average 3	4	Excellent 5	no answer
1	1	3	8	23	45	4

**2. Overall Session Quality (organization, speaker or panel quality, etc.)**

Question #	Poor 1	2	Average 3	4	Excellent 5	no answer
2		1	7	32	41	3

**3. Relevance and value of content to your and your work**

Question #	Poor 1	2	Average 3	4	Excellent 5	no answer
3			7	33	41	3

**4. Conference Registration and Logistics (organized, clear, etc.)**

Question #	Poor 1	2	Average 3	4	Excellent 5	no answer
4	1	4	8	28	43	

**5. Conference Staff (considerate, helpful, etc.)**

Question #	Poor 1	2	Average 3	4	Excellent 5	no answer
5			1	10	70	3

**6. Meeting Facilities, Food, etc.**

Question #	Poor 1	2	Average 3	4	Excellent 5	no answer
6			3	28	52	1

**7. I would attend a future Peer Exchange**

Question #	No	Maybe	Yes	No answer
7		1	79	4

## 6. STEERING COMMITTEE RECOMMENDATIONS

### 6.1. Clarification of Problem Statements

The Steering Committee asked four of its members—Dennis Burkheimer, Tina Greenfield, Lee Smithson and Linda Taylor—to consolidate the original list of 70 research needs statements (page 20) by grouping like problems. The results of that consolidation, with clarifications by the moderator and facilitator for each track, appear below:

- 1. How to determine the proper timing and frequency of anti-icing and deicing.** This was a discussion on determining when and at what rates deicing materials should be applied to the roadway to maximize effectiveness. Items such as product type, pavement temperature, pavement type, relative humidity, precipitation rate and type, etc. The discussion also recommended a guide for when and how much deicer should be used for reapplication of materials.
- 2. Develop anti-icing, deicing and pre-wetting implementation guidelines.** The group felt there was a need to develop a standard set of guidelines or “best practices” that covered anti-icing, deicing and prewetting.
- 3. Synthesis of unconventional staffing strategies to meet increasing demands.** The participants in Track 3 felt government agencies are being downsized but the work load hasn’t been reduced. When faced with critical events such as a major winter storm that must be dealt with in a timely manner, an agency may need to implement unconventional staffing strategies to meet these needs. The thought was to perform a literature search and international survey to determine what transportation agencies have done to meet these needs and prepare a synthesis to document staffing strategies. The synthesis should consider both successes and failures and include a variety of storm scenarios.
- 4. Develop standardized performance measure for snow and ice.** The states were all over the board with performance measure for winter maintenance. There was a need to standard the performance measure so that a roadway classification was consistently set across the United States. Motorist traveling across state boundaries experienced the same level of service of interstate system.
- 5. Are the FHWA TE-28 anti-icing guidelines accurate, appropriate, effective?** The group felt the anti-icing guidelines need to be proven under actual conditions to determine if the application rates are accurate and effective for the different precipitation events and pavement temperatures. The tests were done in the early 1990s and the group felt with advances in technology it should be possible to test the guidelines to see if they are still valid.

- 6. Identify long-term impacts of not funding maintenance fully for summer and winter activities.** The group felt that the impacts of not funding maintenance activities fully would come back and bite us in the future and the cost to replace these system would be much more expensive. The research initiative would identify the maintenance activities that have been eliminated or reduced due to resource reduction and quantify the long term impacts on department and system to raise awareness and support.
  
- 7. Improvements in sensing and forecasting of ice, freezing rain and frost conditions.** This project was suggested because of discussions regarding how hard it is to detect freezing drizzle on radar and common RWIS equipment. Hand-in-hand were issues with freezing rain forecasts, the rain/snow line, and frost forecasts. They observed that sometimes the first indication of any freezing drizzle in the area was a call from the state patrol or your neighboring garage and that is not acceptable.
  
- 8. Determine staffing and funding for core maintenance activities.** The group felt strongly about determining the staffing and funding needed to support the core maintenance activities. Privatization, outsourcing and downsizing has impacted the DOT's ability to adequately perform core maintenance activities (summer and winter). Flexible workforce has helped address needs of winter maintenance but doesn't address the summer needs. Summer crews are under staffed and unable to perform some maintenance function because of lack of resources.
  
- 9. Develop tools to manage and communicate LOS, expectations and costs associated to urban, suburban and rural routes.** DOTs need tools to assist them in managing and communicating with motorists, management, politicians, stakeholders etc. They need effective ways to communicate and explain level of service, expectations, and costs on various roadway systems.
  
- 10. Build a test facility to provide objective data regarding the effectiveness of various winter maintenance treatments.** The group felt there was a strong need for a national test facility that could be used for testing materials, methods and equipment used in winter maintenance. Having a national test center would establish a rigid set of research guidelines, protocols and procedures which should make the results more accurate. Can also test RWIS sensors and MDSS logic at this facility.
  
- 11. Developing the next generation concept vehicle and optimized plow design.** The group felt there was a strong need to continue focusing on new technologies for equipment (robotics, GPS/AVL, zero velocity spreaders and plow design) that would allow operations to be more efficient and effective in the future. The group sensed the work that was done in SHRP and with previous concept vehicle projects was great but wanted to see a national push for developing the next generation snow plow.

- 12. Seamless wireless communication for transferring data from vehicle to maintenance garage.** The scope of this discussion was to develop a standard communication protocol that could be used to move data between systems in a truck and back to a data collection system. I think this was more about developing a set of national standards for data exchange with snowplows that would allow states to use non-proprietary software and hardware to collect data from trucks. Plug and Play technology for snowplows with better integration of existing and new equipment
- 13. Is there a defensive way to determine or establish LOS nationwide (corridor management and seamless LOS across state boundaries)?** Develop a national LOS to better transition motorists across boundaries without sudden change in conditions. (Similar to No. 19). Consistency across state lines is a challenge. This would document successful practices some states have worked out which would help other states gain from these experiences
- 14. Best way to measure the chloride content on the surface and determine how long it lasts.** The group was interested in a real-time feedback of chloride levels and expected time period the chemical could maintain the roadway. The discussion focused on roadside and vehicle mounted sensors along with work in the laboratory. The research can focus on evaluating the accuracy and reliability of devices and their relative performance when dealing with different deicers which would be beneficial for the success of MDSS.
- 15. Support more meetings similar to this one for peer exchange.** I can't think of anything more to say about this one....
- 16. Cost-benefit analysis of winter maintenance equipment purchases and upgrades.** Develop a standard method to measure the cost/benefit of adding different components like wings, guidance systems, GPS, additional sensors, etc., and determining the expected service life of the new equipment.
- 17. Develop on-vehicle salinity sensor.** People wanted to know how much salt was on the road so they could track dilution, re-freeze potential, and how much more chemical (if any) should be applied at that time.
- 18. The importance of post-storm meetings.** The participants in Track 3 felt that the importance of post storm meetings was not recognized by many governmental agencies. A literature search needs to be accomplished and results analyzed to learn what type of information is most valuable to document and share. A survey is needed to determine what is working, how to learn from mistakes, do post-storm meetings improve morale, and have the benefits of post-storm meetings been quantified.

- 19. Determining an appropriate wintertime LOS for specific areas.** Develop a road prioritization formula to determine LOS and see if it can be used nationwide.
- 20. Better use of RWIS and weather forecasts for decision making.** Develop more training on how to use RWIS and weather forecasting to help decision making. Improvements also need to be done to the RWIS for a more accurate chloride sensor for integration into the decision making process. There seems to be a lack of understanding on the correct action to take based on weather conditions and forecasts.
- 21. Best practices in winter maintenance performance (e.g. post-storm assessment).** The participants in Track 3 felt more needed to be understood about balancing politics and performance. What are some best practices in communicating with legislators? What performance metrics seem too meaningful and how to communicate these metrics to the crews. Post-storm assessment is also covered in No. 18 above. Each state has developed best practices in winter maintenance to improve performance. One example was post-storm assessment. These winter maintenance best practices need to be compiled and distributed to states so that they continue to improve winter operators.
- 22. Synthesis of best practices for reducing corrosion on winter maintenance equipment.** Synthesis to include investigation of better designs, use of corrosion resistant materials, coatings, stainless steel, etc. Cost/benefit analysis would need to be included to make sure the practice is cost effective.
- 23. Synthesis of strategies of retaining trained personnel.** The participants in Track 3 felt agencies are losing valuable trained and experienced personnel to other agencies and contractors. More needs to be understood about how to keep these people from going elsewhere to work. Exit interviews need to examine why people are terminating employment and what could be done to make their job more attractive.
- 24. How do we establish appropriate dedicated funding levels for maintenance?** Several state indicated ways they had worked with upper management, legislature, etc. to secure appropriate funding for maintenance. These methods should be examined and documented and the results shared with other states. .
- 25. Investigate alternative blade inserts.** Investigate alternate blade inserts such as taller carbides, ceramics but also look at alternative methods to clear the roadway with one pass. Also of interest is a way to evaluate and compare different models of blades to determine their wear.

- 26. Developing improved precipitation sensor.** Need an RWIS precipitation sensor that is very reliable and can at least do precipitation Yes/No. Precipitation type and rate are desirable as well. Strong emphasis on its ability to sense (at least yes/no) all types of precipitation reliably and ability to live in a roadside environment without frequent maintenance. Sensor needs to be relatively cheap.
- 27. Pilot evaluation of virtual pavement sensors and on-board friction devices.** Develop low-cost, simple friction measuring device or other method to determine slipperiness of roadway surface and transmit that information to users to assist in decision making.
- 28. State-of-the-practice for using driver simulators as a training tool.** The participants in Track 3 felt driver simulators seem to be an attractive training tool. Since they are very costly, management wants to know the payoff for the investment. Can results be measured? How are agencies that have simulators implementing them into their training programs? How do they staff this effort?
- 29. Development of standards for in-vehicle equipment.** Can be combined with No. 12. States cited problems interfacing new or existing spreader or sensor equipment with each other. Need standards so you can be sure that one system will work with the other.
- 30. Can chemical blends cause slippery roads and refreezing?** This focus on “blends” of different deicers. How they might interact to complicate the application and re-application rates/timing and resulting deicing/anti-icing performance. Also discussed optimum pre-wetting rate when use liquid deicer to prewet solid deicer. This effort should include conducting extensive lab and field tests on different deicing products to determine under what conditions the product caused slipperiness on the roadway surface and then determine optimum application rates for prewetting and anti-icing.
- 31. Optimizing the ergonomics for snowplow operators.** Determine if the new technologies, equipment changes or multi-tasking requirements are taxing equipment operators. Investigate the physical characteristics needed in the cab of a snowplow to provide safety and comfort for operators plowing for long periods of time. Also discussed was determining the ideal lighting for a snowplow to see and be seen by the traveling public and how to keep the rear of a plow clean during plowing operations.
- 32. Develop standard ratings and descriptors for road conditions.** Road condition reports vary greatly from one area to another. Also, the interpretation of a given road condition is different to different people. The road itself also can have different conditions along a given road segment. It was felt that we need a standard way of reporting to help bridge these gaps.

- 33. Develop acceptable dynamic messages for snow and ice.** The group felt that common, consistent and uniform snow and ice messages should be developed for the United States. There was concern and confusion over how to present winter messages without generating liability issues.
- 34. Develop standard specifications for components and communications.** To allow plug-and-play to minimize incompatibility of hardware and software and minimize training. Need to work closely with vendors. Could be continuous partnership, e.g., standard specs for GPS/AVL. (Same as No. 12)
- 35. Developing Tools for Outreach.** The participants in Track 3 felt more needed to be done to reach out to the younger audiences to excite them about careers in transportation. What types of promotional materials are being developed and are they affective? What type of education outreach should be done—e.g., presentations at schools, fairs, etc?
- 36. Develop a state winter severity index as a tool to compare materials use and costs (MnDOT, Washington DOT, New Hampshire).** Evaluate the winter severity index tools currently be used by states. The group felt that a uniform and consistent winter severity index needed to be established so that states could normalize performance and costs.
- 37. How to most effectively communicate performance measures and associated costs to internal staff, operators and stakeholders.** (Same as No. 9).
- 38. Need a tool to provide or ensure funding is available to cover salt/sand stockpiles and secondary containments for liquids.** Several states still struggle with meeting the requirement to cover salt/sand stockpiles and provide secondary containments for liquid chemicals. They felt that dedicated funding should be secured to ensure compliance with these environmental requirements.
- 39. Training for how to use technologies (e.g. RWIS, in-vehicle pavement sensors).** The group discussed how lots of maintenance folks are not as RWIS sensor-savvy as they should be. For example, the differences one can expect between in-pavement and infrared road temperature sensor readings under certain conditions.
- 40. Road prioritization formula for winter maintenance LOS.** (Same as No. 13)



- 41. Best practices for balancing politics and performance.** The participants in Track 3 felt that a literature search needs to be done and probably a survey to determine what are the best practices for communicating to legislators the need to establish performance measures and then provide the staffing and funding necessary to meet those measures. There is also a need to be able to communicate performance metrics to field crews so they understand their importance.
- 42. Is there a defensive way to determine or establish LOS nationwide (corridor management and seamless LOS across state boundaries)?** (Same as No. 13)
- 43. Inform stakeholders of the critical activities and impacts of maintenance on daily lives.** The image of maintenance workers is two fold—snowfighters in the winter and slugs in the summer (standing around doing nothing). The image of the maintenance worker needs to be improved. The critical activities of maintenance need to be explained to the public so they understand the how impact their daily lives.
- 44. Investigate what factors influence refreezing on the road.** Investigate all the various factors that may cause refreezing on the roadway in the lab and field, such as weather, previous application, pavement type/structure, product type, application rate, pavement temperature, air temperature, humidity, etc. Can be a different topic than No. 30.
- 45. Investigate collision-avoidance systems for snowplows.** Synthesis of work done in this field that would include investigation of the alert (lights, audible alarms, motion, etc.).
- 46. Explore use of highly detailed satellite imagery in winter maintenance operations.** The goal of this statement is a way to remotely monitor the condition of a road along its full length—not just at certain points like most in-situ sensors do. Something that can be presented visually, like high-detail satellite imagery is optimal.
- 47. Training for maintenance personnel to interpret forecasts.** Forecasts may contain a lot of information that can be easy to misinterpret. Additionally, forecasts often contain information that is missed (clues to tell when a forecast is already off to a bad start, forecast details like wind or relative humidity that can really make a difference to maintenance, etc.). Need more training on not just the weather info in the forecast, but also “reading between the lines.”
- 48. Meeting increasing training challenges.** The participants in Track 3 felt the employment pool is changing. There is a lack of work ethic and work skills. New techniques are needed to fill these work skill gaps and instill a good work ethic.

- 49. Optimization of the in-vehicle driver interface.** Drivers need certain information to help them make appropriate treatment decisions but information overload can be harmful. What information should be presented? How should this information be presented?
- 50. Synthesis of how to effectively relay and communicate winter maintenance budget needs to upper management and legislature.** (Same as No. 24) Develop successful communication strategies to inform, educate and communicate funding maintenance needs to upper management and legislature to ensure adequate funding. They also need to understand the ramifications of not funding maintenance activities and the long-term impacts on the infrastructure.
- 51. Standardized tests for winter maintenance equipment.** May be accelerated lab tests coupled with field evaluation of various brands so that it can be used to determine their service life as an input to the cost-benefit analysis or for side-by-side comparison.
- 52. Improved chemical sensor.** Need a better in-pavement chemical sensor that can reliably tell how much chemical is still out on the road. Current sensors do not seem reliable enough to base decisions.
- 53. Developing methodologies for evaluating training efforts.** The participants in Track 3 felt methods need to be developed to determine if training does make a difference and how this difference can be measured.
- 54. Developing measures of forecast accuracy.** Need a good way to tell how accurate different forecast sources are. This would be used to monitor forecast services and keep track of which sources do the best when you have more than one to look at. Also it can be used to test whether complaints about a new forecaster are real or just because it's new. What is the most accepted way to gather or use observations as "truth"?
- 55. Develop guidelines for BMPS to achieve attainment in areas of concern.** As our groundwater, lakes, and rivers are tested and designated attainment areas, we need to develop guidelines for agencies to effectively manage these areas. What methods are being utilized by other states to meet BMPs and how best to achieve these goals without compromising safety and mobility of motoring public.
- 56. Educating meteorological community about the maintenance personnel's weather information needs.** The group felt that there is a need for more meteorologists who understand the needs of maintenance personnel. Develop a way to educate more forecasters about what maintenance requires in a forecast and how to "speak our language."

- 57. Pursue objective testing to verify the effectiveness of innovative maintenance treatments.**
- 58. Establish seamless boundaries for winter information across states.** (Similar to Nos. 13, 33 and 42.)
- 59. Feedback of customer expectations on winter maintenance.** Several states use customer feedback as a way to manage and determine their targets and performance measures. A synthesis of the different methods used should be documented and evaluated. The most effective approaches should be summarized so that states can more effectively manage customer expectations of maintenance activities.
- 60. Can the road surface refreeze due to over-application of salt?** More research needs to be done to determine under what condition salt may refreeze on the roadway surface. We talked about the right side of a typical phase diagram would imply that the road surface could refreeze due to over application of salt. Needs laboratory investigation and maybe some easy-to-use rules to help practitioners properly use phase diagrams.
- 61. Improvements in forecasting of low-elevation weather conditions.** Similar to No. 7, improvements need to be made in forecasting fog, freezing fog, drizzle, and things which otherwise slip under radar and are hard to monitor and forecast.
- 62. Innovative solutions for real-time vehicle-to-center data communications.** Need to collect or research different solutions to get vehicle data into the department's network or web. Often what works best for one person or area will not work for another so we need pros and cons for many methods. Need low-cost and relatively easy solutions. Communication costs can be quite substantial for equipping a whole fleet so an agency must be able to choose wisely from its available options.
- 63. Develop plan for improving weather forecasts through outreach to meteorological community.** DOT folks need to know what they can do to help make their forecasts better—i.e., do meteorologists need better RWIS, different types of sensors? What do they need from us? Are they getting it?
- 64. FHWA develop pilot/demonstration projects for seamless winter operations (NCHRP 20-74A problem statement).** The FHWA should develop pilot or demonstration projects of seamless winter operations. This would include LOS, winter messages, RWIS, and other technologies. The results of the pilots can be used to establish and/or revise standards and policies.

- 65. Synthesis of innovative methods to compete with industry.** The participants in Track 3 felt a synthesis should be prepared to illustrate innovative ways that government can compete with private sector salaries and benefits. Ways need to be developed to overcome the stigma that government jobs are of lesser value than private sector jobs. Also examine government processes for hiring—do they need to be streamlined to avoid unnecessary delays and other time-consuming seemingly bureaucratic delays.
- 66. What is the true cost of a data collection system (e.g. AVL)?** How much does it cost to get a maintenance data collection system—communication, maintenance, operator time, and equipment? Also, what is the payback? Estimating costs can be hard to do and we need more guidance before we jump in.
- 67. Case studies on ensuring consistency in winter maintenance practice across state borders.**
- 68. Boilerplate language for data sharing.** Concerns over litigation have slowed down the ability of states to share data. This project would develop some standard language that could serve as a starting point for states to address legal issues that may be involved with data sharing. Also nice to know what language is out there and how it has worked for those who put it out.
- 69. Education about microclimates.** Weather can change dramatically in small areas. Local weather quirks are often well-known in the heads of veteran vehicle operators and supervisors, but new employees are at a disadvantage. This project would investigate ways of using technology to “record” the ways that veteran personnel respond to microclimates so if the veteran retires or are otherwise not around, the new employee (or the one who is just from a different area) is armed with much the same knowledge.
- 70. Best practices for snow fences**
- When to use live fences;
  - Cost-benefit considerations;
  - Guidelines for various types of live snow fences (grasses, corn);
  - Understanding political challenges (e.g., killing nice grass before planting natives which look like weeds at first) and dealing with land owners.

## 6.2. Consolidation of Research Problem Statements

After an independent review of the 70 needs statements by each of the four designated committee members, and then a further review by the group together, 27 consolidated research needs statements emerged. The Steering Committee reviewed the 27 consolidated research needs statements and then made a preliminary assignment of each consolidated statement to a research consortium. The table below shows the results of the consolidation. The following is a guide for interpreting the table:

- **Group Rank**—is the overall ranking of the problem after all consolidation was complete. It also represents the total votes for the group.
- **Short Title**—is a suggested short descriptive title for the problem.
- **Total Votes**—is the total number of votes received for this group. It is the sum of the votes for all of the individual problems within the category.
- **No. Votes**—is the original number of votes cast at the Peer Exchange for these individual problems from the original list of 70.
- **Individual Rank**—is the ranking of the individual problems from the original list of 70.
- **Research Needs Statements**—are the actual 70 problems that have now been grouped together into like problems.
- **Research Group**—is the suggested research consortium to take ownership of the problem and shepherd it to some type of resolution.

Group Rank	Short Title	Total Votes	No. Votes	Individual Rank	Research Needs Statements	Research Group
1	Guidelines for anti-icing and deicing	191	72	1	How to determine the proper timing and frequency of anti-icing and deicing? This was a discussion on determining when and at what rates deicing materials should be applied to the roadway to maximize effectiveness. Items such as product type, pavement temperature, pavement type, relative humidity, precipitation rate and type, etc. The discussion also recommended a guide for when and how much deicer should be used for reapplication of materials.	Clear Roads
			62	2	Develop anti-icing, deicing and pre-wetting implementation guidelines. The group felt there was a need to develop a standard set of guidelines or “best practices” that covered anti-icing, deicing and prewetting.	
			57	5	Are the FHWA TE-28 anti-icing guidelines accurate, appropriate, effective? The group felt the anti-icing guidelines need to be proven under actual conditions to determine if the application rates are accurate and effective for the different precipitation events and pavement temperatures. The tests were done in the early 1990’s and the group felt with advances in technology it should be possible to test these guidelines to see if they are still valid.	
2	Staffing	129	61	3	Synthesis of unconventional staffing strategies to meet increasing demands. The participants in Track 3 felt government agencies are being downsized but the work load hasn’t been reduced. When faced with critical events such as a major winter storm that must be dealt with in a timely manner, an agency may need to implement unconventional staffing strategies to meet these needs. The thought was to perform a literature search and international survey to determine what transportation agencies have done to meet these needs and prepare a synthesis to document staffing strategies. The synthesis should consider both successes and failures and include a variety of storm scenarios.	TRB
			21	35	Developing Tools for Outreach. The participants in Track 3 felt more needed to be done to reach out to the younger audiences to excite them about careers in transportation. What types of promotional materials are being developed and are they affective? What type of education outreach should be done, i.e. presentations at schools, fairs, etc?	
			15	48	Meeting increasing training challenges. The participants in Track 3 felt the employment pool is changing. There is a lack of work ethic and work skills. New techniques are needed to fill these work skill gaps and instill a good work ethic.	
			27	23	Synthesis of strategies of retaining trained personnel. The participants in Track 3 felt agencies are losing valuable trained and experienced personnel to other agencies and contractors. More needs to be understood about how to keep these people from going elsewhere to work. Exit interviews need to examine why people are terminating employment and what could be done to make their job more attractive.	

Group Rank	Short Title	Total Votes	No. Votes	Individual Rank	Research Needs Statements	Research Group
			5	65	Synthesis of innovative methods to compete with industry. The participants in Track 3 felt a synthesis needs to be prepared to illustrate innovative ways that government can compete with private sector salaries and benefits. Ways need to be developed to overcome the stigma that government jobs are of lesser value than private sector jobs. Also examine government processes for hiring, do they need to be streamlined to avoid unnecessary delays and other time consuming seemingly bureaucratic delays.	
3	LOS Determination	117	18	40	Road prioritization formula for winter maintenance LOS	TRB
			5	67	Case studies on ensuring consistency in winter maintenance practice across state borders	
			8	58	Establish seamless boundaries for winter information across states	
			34	13	Is there a defensive way to determine or establish LOS nation wide (corridor management and seamless LOS across state boundaries)? Develop a national LOS to better transition motorists across boundaries without sudden change in conditions. (Similar to 19). Consistency across state lines is a challenge. This would document successful practices some states have worked out which would help other states gain from these experiences	
			17	42	Is there a defensive way to determine or establish LOS nationwide (corridor management and seamless LOS across state boundaries)?	
			5	64	FHWA develop pilot/demonstration projects for seamless winter operations (NCHRP 20-74A problem statement). The FHWA should develop pilot or demonstration projects of seamless winter operations. This would include LOS, winter messages, RWIS, and other technologies. The results of the pilots can be used to establish and/or revise standards and policies.	
			30	19	Determining an appropriate wintertime LOS for specific areas. Develop a road prioritization formula to determine LOS and see if it can be used nationwide	
4	Funding	109	40	8	Determine staffing and funding for core maintenance activities. The group felt strongly about determining the staffing and funding needed to support the core maintenance activities. Privatization, outsourcing and downsizing has impacted the DOT's ability to adequately perform core maintenance activities (summer and winter). Flexible workforce has helped address needs of winter maintenance but doesn't address the summer needs. Summer crews are under staffed and unable to perform some maintenance function because of lack of resources.	TRB

Group Rank	Short Title	Total Votes	No. Votes	Individual Rank	Research Needs Statements	Research Group
			43	6	Identify long-term impacts of not funding maintenance fully for summer and winter activities. The group felt that the impacts of not funding maintenance activities fully would come back and bite us in the future and the cost to replace these system would be much more expensive. The research initiative would identify the maintenance activities that have been eliminated or reduced due to resource reduction and quantify the long term impacts on department and system to raise awareness and support.	
			26	24	How do we establish appropriate dedicated funding levels for maintenance? Several state indicated ways they had worked with upper management, legislature, etc. to secure appropriate funding for maintenance. These methods should be examined and documented and the results shared with other states.	
5	Communication with public and legislators	105	39	9	Develop tools to manage and communicate LOS, expectations and costs associated to urban, sub-urban and rural routes. DOT's need tools to be developed to assist them in managing and communicating with motorists, management, politicians, stakeholders etc. They need effective ways to communicate and explain level of service, expectations, and costs on various roadway systems.	Clear Roads
			18	41	Best practices for balancing politics and performance. The participants in Track 3 felt that a literature search needs to be done and probably a survey to determine what are the best practices for communicating to legislators the need to establish performance measures and then provide the staffing and funding necessary to meet those measures. There is also a need to be able to communicate performance metrics to field crews so they understand their importance.	
			12	50	Synthesis of how to effectively relay and communicate winter maintenance budget's needs to upper management and legislature. Develop successful communication strategies to inform, educate and communicate funding maintenance needs to upper management and legislature to ensure adequate funding. They also need to understand the ramifications of not funding maintenance activities and the long term impacts on the infrastructure.	
			19	37	How to most effectively communicate performance measures and associated costs to internal staff, operators and stakeholders. (Same as 9).	
			17	43	Inform stakeholders of the critical activities and impacts of maintenance on daily lives. The image of maintenance workers is two fold – snowfighters in the winter and slugs in the summer (standing around doing nothing). The image of the maintenance worker needs to be improved. The critical activities of maintenance need to be explained to the public so they understand the how impact their daily lives.	



Group Rank	Short Title	Total Votes	No. Votes	Individual Rank	Research Needs Statements	Research Group
6	Vehicle to Center communication	89	35	12	Seamless wireless communication for transferring data from vehicle to maintenance garage. The scope of this discussion was to develop a standard communication protocol that could be used to move data between systems in a truck and back to a data collection system. I think this was more about developing a set of national standards for data exchange with snowplows that would allow states to use non-proprietary software and hardware to collect data from trucks. Plug and Play technology for snowplows with better integration of existing and new equipment	Clear Roads
			25	29	Development of standards for in-vehicle equipment. Can be combined with 12. States cited problems interfacing new or existing spreader or sensor equipment with each other. Need standards so you can be sure that one system will work with the other.	
			8	62	Innovative solutions for real-time vehicle-to-center data communications. Need to collect or research different solutions to get vehicle data into the department's network or web. Often what works best for one person or area will not work for another so we need pros and cons for many methods. Need low-cost and relatively easy solutions. Communication costs can be quite substantial for equipping a whole fleet so an agency must be able to choose wisely from its available options.	
			21	34	Develop standard specifications for components and communications. To allow plug-and-play to minimize incompatibility of hardware and software and minimize training. Need to work closely with vendors. Could be continuous partnership. e.g. standard specs for GPS/AVL. (Same as 12)	
7	Performance measurement	87	59	4	Develop standardized performance measure for snow and ice. The states were all over the board with performance measure for winter maintenance. There was a need to standard the performance measure so that a roadway classification was consistently set across the US. Motorist traveling across state boundaries experienced the same level of service of interstate system.	TRB
			20	36	Develop a state winter severity index as a tool to compare materials use and costs (MnDOT, Washington DOT, New Hampshire) Evaluate the winter severity index tools currently be used by states. The group felt that a uniform and consistent winter severity index needed to be established so that states could normalize performance and costs.	
			8	59	Feedback of customers' expectations on winter maintenance. Several states use customer feedback as a way to manage and determine their targets and performance measures. A synthesis of the different methods used should be documented and evaluated. The most effective approaches should be summarized so that states can more effectively manage customer expectations of maintenance activities.	

Group Rank	Short Title	Total Votes	No. Votes	Individual Rank	Research Needs Statements	Research Group
8	Weather and RWIS education	81	28	20	Better use of RWIS and weather forecasts for decision making. Develop more training on how to use RWIS and weather forecasting to help decision making. Improvements also need to be done to the RWIS for a more accurate chloride sensor for integration into the decision making process. There seems to be a lack of understanding on the correct action to take based on weather conditions and forecasts.	Aurora
			9	56	Educating meteorological community about the maintenance personnel's weather information needs. The group felt that there needs to be more meteorologists who understand the needs of maintenance personnel. Need to develop a way to educate more forecasters about what maintenance needs in a forecast and how to 'speak our language'.	
			7	63	Develop plan for improving weather forecasts through outreach to meteorological community. DOT folks need to know what they can do to help make their forecasts better – i.e., do meteorologists need better RWIS, different types of sensors? What do they need from us? Are they getting it?	
			16	47	Training for maintenance personnel to interpret forecasts. Forecasts may contain a lot of information that can be easy to misinterpret. Additionally, forecasts often contain information that is missed (clues to tell when a forecast is already off to a bad start, forecast details like wind or relative humidity that can really make a difference to maintenance, etc.) Need more training on not just the weather info in the forecast, but also 'reading between the lines'.	
			19	39	Training for how to use technologies (e.g. RWIS, in-vehicle pavement sensors). The group discussed how lots of maintenance folks are not as RWIS sensor-savvy as they should be. For example, the differences one can expect between in-pavement and infrared road temperature sensor readings under certain conditions.	
			2	69	Education about microclimates. Weather can change dramatically in small areas. Local weather quirks are often well-known in the heads of veteran vehicle operators and supervisors, but new employees are at a disadvantage. This project would investigate ways of using technology to "record" the ways that veteran personnel respond to microclimates so if the veteran retires or otherwise not around, the new employee (or the one who is just from a different area) is armed with much the same knowledge.	
9	Salinity sensor	79	33	17	Develop on-vehicle salinity sensor People wanted to know how much salt was on the road so they could track dilution, re-freeze potential, and how much more chemical (if any) should be applied at that time.	Aurora

Group Rank	Short Title	Total Votes	No. Votes	Individual Rank	Research Needs Statements	Research Group
			34	14	Best way to measure the chloride content on the surface and determine how long they last. The group was interested in a real-time feedback of chloride levels and expected time period the chemical could maintain the roadway. The discussion focused on roadside and vehicle mounted sensors along with work in the laboratory. The research can focus on evaluating the accuracy and reliability of devices and their relative performance when dealing with different deicers which would be beneficial for the success of MDSS.	
			12	52	Improved chemical sensor. Need a better in-pavement chemical sensor that can reliably tell how much chemical is still out on the road. Current sensors do not seem reliable enough to base decisions.	
10	Light precipitation forecasting and sensing	76	42	7	Improvements in sensing and forecasting of ice, freezing rain and frost conditions. This project was suggested because of discussions regarding how hard it is to detect freezing drizzle on radar and common RWIS equipment. Hand-in-hand were issues with freezing rain forecasts, the rain/snow line, and frost forecasts. They observed that sometimes the first indication of any freezing drizzle in the area was a call from the state patrol or your neighboring garage and that is not acceptable.	Aurora
			26	26	Developing improved precipitation sensor. Need an RWIS precipitation sensor that is very reliable and can at least do precipitation Yes/No. Precipitation type and rate are desirable as well. Strong emphasis on its ability to sense (at least yes/no) all types of precipitation reliably and ability to live in a roadside environment without frequent maintenance. Sensor needs to be relatively cheap.	
			8	61	Improvements in forecasting of low-elevation weather conditions. Similar to 7, improvements need to be made in forecasting fog, freezing fog, drizzle, and things which otherwise slip under radar and are hard to monitor and forecast.	
11	Concept Vehicle	71	36	11	Developing the next generation concept vehicle and optimized plow design. The group felt there was a strong need to continue focusing on new technologies for equipment (robotics, GPS/AVL, zero velocity spreaders and plow design that would allow operations to be more efficient and effective in the future. The group sensed the work that was done in SHRP and with previous concept vehicle projects was great but wanted to see a national push for developing the next generation snow plow.	Clear Roads

Group Rank	Short Title	Total Votes	No. Votes	Individual Rank	Research Needs Statements	Research Group
			22	31	Optimizing the ergonomics for snowplow operators. Determine if the new technologies, equipment changes or multi-tasking requirements are taxing equipment operators. Investigate the physical characteristics needed in the cab of a snowplow to provide safety and comfort for operators plowing for long periods of time. Also discussed was determining the ideal lighting for a snowplow to see and be seen by the traveling public and how to keep the rear of a plow clean during plowing operations.	
			13	49	Optimization of the in-vehicle driver interface. Drivers need certain information to help them make appropriate treatment decisions but Information overload can be harmful. What information should be presented? How should this information be presented?	
12	Post storm meetings	59	32	18	The importance of post storm meetings. The participants in Track 3 felt that the importance of post storm meetings was not recognized by many governmental agencies. A literature search needs to be accomplished and results analyzed to learn what type of information is most valuable to document and share. A survey needs to be conducted to determine what is working, how to learn from mistakes, do post storm meetings improve morale, and have the benefits of post storm meetings been quantified.	Clear Roads
			27	21	Best practices in winter maintenance performance (e.g. post storm assessment). The participants in Track 3 felt more needed to be understood about balancing politics and performance. What are some best practices in communicating with legislators? What performance metrics seem too meaningful and how to communicate these metrics to the crews. Post storm assessment is also covered in #18 above. Each state has developed best practices in winter maintenance to improve performance. One example was post storm assessment. These winter maintenance best practices need to be compiled and distributed to states so that they continue to improve winter operators.	
13	Field Testing	58	37	10	Build a test facility to provide objective data regarding the effectiveness of various winter maintenance treatments. The group felt there was a strong need for a national test facility that could be used for testing materials, methods and equipment used in winter maintenance. Having a national test center would establish a rigid set of research guidelines, protocols and procedures which should make the results more accurate. Can also test RWIS sensors and MDSS logic at this facility.	SICOP
			9	57	Pursue objective testing to verify the effectiveness of innovative maintenance treatments	

Group Rank	Short Title	Total Votes	No. Votes	Individual Rank	Research Needs Statements	Research Group
			12	51	Standardized tests for winter maintenance equipment. May be accelerated lab tests coupled with field evaluation of various brands so that it can be used to determine their service life as an input to the cost-benefit analysis or for side-by-side comparison.	
14	Chemicals and Refreeze	47	22	30	Can chemical blends cause slippery and refreezing? This focus on “blends” of different deicers. How they might interact to complicate the application and re-application rates/timing and resulting deicing/anti-icing performance. Also discussed optimum pre-wetting rate when use liquid deicer to prewet solid deicer. This effort should include conducting extensive lab and field tests on different deicing products to determine under what conditions the product caused slipperiness on the roadway surface and then determine optimum application rates for prewetting and anti-icing.	PNS
			17	44	Investigate what factors influence refreezing on the road. Investigate all the various factors that may cause refreezing on the roadway in the lab and field, such as weather, previous application, pavement type/structure, product type, application rate, pavement temperature, air temperature, humidity, etc. Can be a different topic than 30.	
			8	60	Can the road surface refreeze due to over application of salt? More research needs to be done to determine under what condition salt may refreeze on the roadway surface We talked about the right side of a typical phase diagram would imply that the road surface could refreeze due to over application of salt. Needs laboratory investigation and maybe some easy-to-use rules to help practitioners properly use phase diagrams.	
15	Consistent descriptions of road conditions	43	22	32	Develop standard ratings and descriptors for road conditions. Road condition reports vary greatly from one area to another. Also, the interpretation of a given road condition is different to different people. The road itself also can have different conditions along a given road segment. It was felt that we need a standard way of reporting to help bridge these gaps.	SICOP
			21	33	Develop acceptable dynamic messages for snow and ice. The group felt that common, consistent and uniform snow and ice messages should be developed for the US. There was concern and confusion over how to present winter messages without generating liability issues.	
16	Cost Benefit for equipment	38	33	16	Cost-benefit analysis of winter maintenance equipment purchases and upgrades. Develop a standard method to measure the cost/benefit of adding different components like wings, guidance systems, GPS, additional sensors, etc. and determining the expected service life of the new equipment.	Clear Roads

Group Rank	Short Title	Total Votes	No. Votes	Individual Rank	Research Needs Statements	Research Group
			5	66	What is the true cost of a data collection system (e.g. AVL)? How much does it cost to get a maintenance data collection system – communication, maintenance, operator time, and equipment? Also, what is the payback? Estimating costs can be hard to do and we need more guidance before we jump in.	
17	Training	38	28	28	State-of-the-Practice for using driver simulators as a training tool. The participants in Track 3 felt driver simulators seem to be an attractive training tool. Since they are very costly, management wants to know the payoff for the investment. Can results be measured? How are agencies that have simulators implementing them into their training programs? How do they staff this effort?	Clear Roads
			10	53	Developing methodologies for evaluating training efforts. The participants in Track 3 felt methods need to be developed to determine if training does make a difference and how this difference can be measured.	
18	Peer Exchange	34	34	15	Support more meetings similar to this one for peer exchange. I can't think of anything more to say about this one....	SICOP
19	Environmental	28	9	55	Develop guidelines for BMPS to achieve attainment in areas of concern. As our groundwater, lakes, and rivers are tested and designated attainment areas, we need to develop guidelines for agencies to effectively manage these areas. What methods are being utilized by other states to meet BMPs and how best to achieve these goals without compromising safety and mobility of motoring public.	PNS
			19	38	Need a tool to provide or ensure funding is available to cover salt/sand stockpiles and secondary containments for liquids. Several states still struggle with meeting the requirement to cover salt/sand stockpiles and provide secondary containments for liquid chemicals. They felt that dedicated funding should be secured to ensure compliance with these environmental requirements.	
20	Reducing Corrosion	27	27	22	Synthesis of best practices for reducing corrosion on winter maintenance equipment. Synthesis to include investigation of better designs, use of corrosion resistant materials, coatings, stainless steel, etc. Cost/benefit analysis would need to be included to make sure the practice is cost effective.	PNS
21	Blade Inserts	26	26	25	Investigate alternative blade inserts. Investigate alternate blade inserts such as taller carbides, ceramics but also look at alternative methods to clear the roadway with one pass. Also of interest is a way to evaluate and compare different models of blades to determine their wear.	Clear Roads
22	Cheap Friction	25	25	27	Pilot evaluation of virtual pavement sensors and on-board friction devices. Develop low-cost, simple friction measuring device or other method to determine slipperiness of roadway surface and transmit that information to users to assist in decision making.	Aurora

Group Rank	Short Title	Total Votes	No. Votes	Individual Rank	Research Needs Statements	Research Group
23	Collision Avoidance	17	17	45	Investigate collision avoidance systems for snowplows. Synthesis of work done in this field that would include investigation of the alert (lights, audible alarms, motion, etc.)	Clear Roads
24	High-def imaging/sensing of road conditions	17	17	46	Explore use of highly detailed satellite imagery in winter maintenance operations. The goal of this statement is a way to remotely monitor the condition of a road along its full length – not just at certain points like most in-situ sensors do. Something that can be presented visually, like high-detail satellite imagery is optimal.	Aurora
25	Forecast accuracy	10	10	54	Developing measures of forecast accuracy. Need a good way to tell how accurate different forecast sources are. This would be used to monitor forecast services and keep track of which sources do the best when you have more than one to look at. Also it can be used to test whether complaints about a new forecaster are real or just because it's new. What is the most accepted way to gather or use observations as 'truth'?	Aurora
26	Boilerplate legal language	4	4	68	Boilerplate language for data sharing Concerns over litigation have slowed down the ability of states to share data. This project would develop some standard language that could serve as a starting point for states to address legal issues that may be involved with data sharing. Also nice to know what language is out there and how it has worked for those who put it out.	SICOP
27	Snowfences	2	2	70	Best practices for snow fences—when to use live fences, cost benefit considerations, guidelines for various types of live snow fences (grasses, corn), and understanding political challenges (e.g. killing nice grass before planting natives which look like weeds at first) and dealing with landowners	Clear Roads

## 7. APPENDIX A: ATTENDEE LIST

### Winter Maintenance Peer Exchange Attendee Information

Agency	Attendee #1	Attendee #2	Additional Attendee(s)
AASHTO	<p>Monica E. Glover Deputy Director, Meetings American Association of State And Highway Transportation Officials 444 N. Capitol Street, NW Suite 249 Washington, DC 20001 202-624-3696 o 202-624-7788 f mglover@aaashto.org www.transportation.org</p>		<p>Leland Smithson leland.smithson@dot.iowa. gov 515-239-1519</p>
APWA			<p>Ashley Scherzer Project Manager - Adult Learning American Public Works Association ascherzer@APWA.NET (800) 848-2792 x5214 (voice) (816) 595-5314 (fax)</p>
Alaska	<p>Steve Potter Fairbanks District Maintenance Manager 2301 Peger Road Fairbanks, AK 99709 907-451-5276 steve_potter@dot.state.ak.us</p>	<p>Neal Henslee MatSu District Maintenance Foreman 289 Inner Springer Loop Palmer, Alaska 99645 907-745-2159 neal.henslee@alaska.gov</p>	
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CTRE	<p>Tom Maze Iowa State University</p>		
Colorado	<p>Phillip Anderle Colorado Department of Transportation Highway Operations &amp; Maintenance 970-350-2120</p>	<p>Paul DeJulio Colorado Department of Transportation Highway Operations &amp; Maintenance 970-385-1650</p>	



Agency	Attendee #1	Attendee #2	Additional Attendee(s)
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FHWA			Pat Kennedy Transportation Specialist, Office of Transportation Operations 1200 New Jersey Ave, SE (Room E86-203) Washington, DC 20590 202-366-9498 (Office) pat.kennedy@dot.gov 202- 366-9498 (Office) 202-366- 3225 (Fax)
Idaho	Ron Wright Chemist Supervisor P.O. Box 7129 Boise, ID 83707 208-334-8453 ron.wright@itd.idaho.gov	Brent Jennings Highway Operations and Safety Engineer P.O. Box 7129 Boise, ID 83707 208-334-8557 brent.jennings@itd.idaho.gov	
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Iowa	Tina Greenfield RWIS Coordinator 800 Lincoln Way Office Maintenance Ames, IA 50010 515-233-7746 tina.greenfield@dot.iowa.gov	Dennis Burkheimer Winter Operations Administrator 800 Lincoln Way Office Maintenance Ames, IA 50010 515-239-1355 dennis.burkheimer@dot.iowa.gov	

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Nevada	Richard Nelson Assistant Director - Operations 1263 S. Steward St. Carson City, NV 89712 775-888-7440 rnelson@dot.state.nv.us	Bill Hoffman Chief Maintenance & Operations Engineer 1263 S. Steward St. Carson City, NV 89712 775-888-7050 whoffman@dot.state.nv.us	
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New Jersey	David Bowlby Winter Maintenance Program 1035 Parkway Ave. Trenton, NJ 08625 609-530-2815 david.bowlby@dot.state.nj.us		
New Mexico	Jeff Lowry Assistant Maintenance Support Engineer P.O. Box 1149, SB2 Santa Fe, NM 87504 505-827-5408 jeff.lowry@state.nm.us		
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Pennsylvania	W. James Smith Acting Director Bureau of Maintenance and Operations 400 North St. 6th Floor P.O. Box 2857 Harrisburg, PA 17105 717-787-6877 walsmith@state.pa.us	David Hughes RWIS and Winter Services Program Manager 400 North St. 6th Floor P.O. Box 2857 Harrisburg, PA 17105 717-705-1421 dahughes@state.pa.us	

Agency	Attendee #1	Attendee #2	Additional Attendee(s)
Rhode Island	Rhode Island will not be able to send a representative to this year's Peer Exchange, but did answer the survey questions to help better the event. Rhode Island would like to receive information that comes out of the Peer Exchange.		
Tennessee	Joe Holt Transportation Manager 2 400 James K. Polk Bldg. Nashville, TN 37243 615-741-2027 joe.holt@state.tn.us	Estel Hagewood Transportation Manager 1 400 James K. Polk Bldg. Nashville, TN 37243 615-741-2027 estel.hagewood@state.tn.us	
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Vermont	Wayne Gammell District Transportation Administrator for Districts 1 and 2	James Cota General Maintenance Manager for District 9	
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Washington DC	Aaron Horton Deputy Chief Engineer, Maintenance & Asset Management 64 New York Ave., NE Washington DC, 20002 202-671-4679 202-359-0961(cell) aaron.horton@dc.gov	Leonard Addison Snow & Fleet Coordinator 64 New York Ave., NE Washington DC, 20002 202-671-4672 202-373-8515(cell) leonard.addison@dc.gov	

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Washington State	Tom Root Assistant State Maintenance Engineer P.O. Box 47538 Olympia, WA 98504-7358 (360) 705-7857 roott@wsdot.wa.gov	Monty Mills Maintenance and Operation Branch Manager PO Box 47538 Olympia, WA 98504-7358 (360) 705-7803 millsm@wsdot.wa.gov	
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Wyoming	Clifford Spoonemore Winter Research Services - Principal Engineer 5300 Bishop Blvd. Cheyenne, WY 82009 307-777-4053 cliif.spoonemore@dot.state.wy.us	James Montuoro District Maintenance Engineer - Rock Springs PO Box 1260 Rock Springs, WY 82902 307-352-3034 james.montuoro@dot. state.wy.us	

Agency	Attendee #1	Attendee #2	Additional Attendee(s)
WTI			<p>Laura Fay Research Scientist Admin support for the exchange laura.fay@coe.montana.edu</p> <p>Xianming Shi Associate Research Professor/Program Manager Moderator for the exchange xianming_s@coe.montana.edu</p> <p>Dan Williams Research Associate Moderator for the exchange dan.williams@coe.montana.edu</p> <p>Eli Cuelho Research Engineer/Program Manager Moderator for the exchange elic@coe.montana.edu</p> <p>Chris Strong Research Engineer/Program Manager Moderator for the exchange chriss@coe.montana.edu</p> <p>Western Transportation Institute P.O. Box 174250 Bozeman, MT 59717-4250</p>

### 8. APPENDIX B: SUMMARY OF TRACKS

TRACK ONE	<i>Moderator: Dan Williams</i>	<i>Facilitators: Ron Wright, Linda Taylor</i>
<b>Increasing Expectations</b>	<b>Discussion Questions</b>	<b>State Information</b>
<ul style="list-style-type: none"> <li>• State growth and service</li> <li>• Financing the level of service</li> <li>• Manpower for Winter Maintenance</li> <li>• Additional infrastructure and lane mile additions. How to cover?</li> <li>• Public expectations: Having to clear more lane miles with the same or less numbers of people and equipment</li> <li>• Accomplishing level of service expectations under current budget constraints.</li> </ul>	<ul style="list-style-type: none"> <li>• What are your options when you end up with more lane miles to maintain and no increase or a reduction in funds to do the job?</li> <li>• You strive hard to do a better job for your customers. With an increased work load or reduced funds will your customers allow you to reduce your level of service of the past? What can you do?</li> <li>• Do you have the maintenance staff you need to do the work?                         <ul style="list-style-type: none"> <li>○ Are they adequately trained,</li> <li>○ A lot of retirements in the future,</li> <li>○ Are they paid enough to keep them?</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• CT has just gone over to a liquid calcium chloride product and have almost eliminated the use of sand.</li> <li>• ID-Just in time liquid applications</li> <li>• IA-Liquid deicer program</li> <li>• KY-Anti-icing Practices and Procedures</li> <li>• KY-Outsourcing - Practices and Procedures</li> <li>• NH-I-93 salt brine program</li> <li>• TN-Newest innovation (not very new) is anti-icing. A successful program</li> </ul>
<b>Performance measurement</b>	<b>Discussion Questions</b>	<b>State Information</b>
<ul style="list-style-type: none"> <li>• Quantifying winter severity from one year to the next</li> <li>• Improving measurement of performance</li> <li>• Developing snow and ice performance measures</li> <li>• Rating level of service during storms</li> </ul>	<ul style="list-style-type: none"> <li>• Do you have clear level of service guidelines based on traffic levels?</li> <li>• As an event actually develops, how do you adjust your resources?</li> <li>• Does your staff know when to use liquid chemicals, when to use solid chemicals and how much they should apply? And, do they know when they have met their goals on a particular route?</li> <li>• How do you track and record use of labor, equipment and materials?</li> <li>• How do you communicate</li> </ul>	<ul style="list-style-type: none"> <li>• KY-Outsourcing - Practices and Procedures</li> <li>• ME-WiFi data download from ground speed control</li> <li>• MN-Winter Performance Measures (Bare Lane, Omnibus and Trade-off studies)</li> <li>• NB-Snowplow Management with AVL</li> <li>• NY-Progressing the use of AVL in conjunction with moss</li> <li>• ND-MDSS, AVL, Incorporating Highway Performance Classification System into</li> </ul>



TRACK ONE	<i>Moderator: Dan Williams</i>	<i>Facilitators: Ron Wright, Linda Taylor</i>
	<p>your storm plan and driving conditions to the public?</p> <ul style="list-style-type: none"> <li>• How do you know what you are doing is correct?</li> </ul>	<p>Snow &amp; Ice Control</p> <ul style="list-style-type: none"> <li>• ND-MDSS, AVL, Incorporating Highway Performance Classification System into Snow &amp; Ice Control</li> </ul>

Environmental impacts	Discussion Questions	State Information
<ul style="list-style-type: none"> <li>• Public opposition to chemicals</li> <li>• Growing concern of environmental impacts</li> <li>• Chemical impacts on the environment</li> </ul>	<ul style="list-style-type: none"> <li>• Do you have air quality (PM-10 or water quality (TMDL) non-compliance issues in your area?</li> <li>• Do you have areas sensitive to chloride loading?</li> <li>• Are your stockpiled chemicals and salt/sand piles protected from the elements?</li> <li>• Is roadside vegetation sensitive to chloride impacts or public opinion?</li> <li>• Does the public understand the function of a roadway corridor and the impacts of maintenance activities?</li> </ul>	<ul style="list-style-type: none"> <li>• CT has just gone over to a liquid calcium chloride product and have almost eliminated the use of sand.</li> <li>• ID-Just in time liquid applications</li> <li>• ID-Inhibitors for salt brines</li> <li>• ID-Reduction on antidiskid use</li> <li>• IL-Experimentation with Ag byproducts such as Ice Ban and Geomelt</li> <li>• MN-Winter Pilot Projects - reducing application rates, Metropolitan Winter Operations, Anti-icing Program, and AVL Efforts</li> <li>• MT-Equipment features, truck calibrations and what we are doing in Montana to reduce abrasives</li> <li>• NH-I-93 salt brine program</li> </ul>

TRACK TWO		
	<i>Moderator: Xianming Shi</i>	<i>Facilitators: Tom Root, Dennis Burkheimer</i>
Decision Making Skills	Discussion Questions	State Information
<ul style="list-style-type: none"> <li>• Best application rates for conditions and proper materials and applications</li> <li>• Lessening salt usage</li> <li>• Correct application rates of de-icing chemicals during winter maintenance operations</li> <li>• Salt application rates</li> <li>• Deicer; effective and efficient decision making</li> <li>• Knowing when to efficiently and effectively deploy</li> <li>• Keeping roads clear with minimal resources</li> </ul>	<ul style="list-style-type: none"> <li>• What are your current decision making challenges related to snow and ice control?</li> <li>• How do you decide the timing and frequency of chemical applications?</li> <li>• What are the knowledge, equipment and material gaps?</li> </ul>	<ul style="list-style-type: none"> <li>• ID-Just in time liquid applications</li> <li>• CT has just gone over to a liquid calcium chloride product and have almost eliminated the use of sand.</li> <li>• IL-Installation of brine making systems capable of blending multiple chemicals</li> <li>• IA-Winter training program - modular system</li> <li>• KS-MDSS</li> <li>• KY-Anti-icing Practices and Procedures</li> <li>• KY-Emergency Salt Stockpile Procedures</li> <li>• MN-Maintenance Training (SPOT, simulator, environmental training &amp; core training)</li> <li>• MN-Winter Pilot Projects - reducing application rates, Metropolitan Winter Operations, Anti-icing Program, and AVL Efforts</li> <li>• ND-MDSS, AVL, Incorporating Highway Performance Classification System into Snow &amp; Ice Control</li> <li>• TN-Newest innovation (not very new) is anti-icing. A successful program</li> <li>• WA'-Challenges of snow and ice operations in Washington's different climatic zones.</li> <li>• WA-Avalanche control operations on the passes in the Washington Cascade's</li> <li>• WA-Recent experiments with solid anti-icer.</li> </ul>

TRACK TWO		
	<i>Moderator: Xianming Shi</i>	<i>Facilitators: Tom Root, Dennis Burkheimer</i>
Dealing with refreeze	Discussion Questions	State Information
<ul style="list-style-type: none"> <li>• Keep road friction at safe level during temperature fluctuations</li> <li>• Re-freeze of treated pavements</li> <li>• Managing brine concentration on the road to prevent refreeze</li> </ul>	<ul style="list-style-type: none"> <li>• How do you deal with the problem of refreezing of treated pavement?</li> <li>• What are the knowledge, material and equipment gaps related to refreezing?</li> </ul>	<ul style="list-style-type: none"> <li>• ID-Just in time liquid applications</li> <li>• IL-The use of increased amount of prewet liquids up to 57 gal/ton</li> <li>• IN-Safe Lane Performance</li> <li>• WA-Challenges of snow and ice operations in Washington’s different climatic zones.</li> <li>• WA-Recent experiments with solid anti-icer.</li> </ul>
Equipment	Discussion Questions	State Information
<ul style="list-style-type: none"> <li>• Equipment funding and utilization</li> <li>• Need optimum snowplow designs for high speed plowing and for fuel economy</li> </ul>	<ul style="list-style-type: none"> <li>• What challenges do you face with your snow and ice control equipment?</li> <li>• Do you have promising solutions regarding snow and ice equipment?</li> </ul>	<ul style="list-style-type: none"> <li>• ID-Inhibitors for salt brines</li> <li>• IL-The use of increased amount of prewet liquids up to 57 gal/ton</li> <li>• IL-Joystick controls</li> <li>• IL-Installation of brine making systems capable of blending multiple chemicals</li> <li>• IL-Dual spinners</li> <li>• IA'-Multiple blade plow system</li> <li>• MO-One pass clearing using 14' wide snowplows and TowPlows</li> <li>• MT-Equipment features, truck calibrations and what we are doing in Montana to reduce abrasives</li> <li>• NH-I-93 salt brine program</li> <li>• UT-Wing plow laser guidance systems</li> <li>• UT-Stainless steel spreader boxes</li> <li>• WA-Recent experiments with solid anti-icer.</li> </ul>

TRACK THREE		
	<i>Moderator: Eli Cuelho</i>	<i>Facilitators: Diana Clonch, Lee Smithson</i>
Staffing Issues	Discussion Questions	State Information
<ul style="list-style-type: none"> <li>• Scheduling manpower during an extended storm event</li> <li>• Lack of adequate maintenance personnel</li> <li>• Lots of inexperienced operators due to retirements</li> <li>• Staffing - retention and training (seasonal, temporary and program delivery workers)</li> <li>• Personnel/Equipment requirements for severe long duration events</li> <li>• Budgetary constraints related to hiring personnel</li> <li>• Staffing levels</li> </ul>	<ul style="list-style-type: none"> <li>• What kinds of creative solutions have you implemented in your jurisdiction to help retain staff longer (budgetary, incentives/rewards,</li> <li>• Do you offer any incentives or pay increases to retain employees?</li> <li>• Do you have any public-private partnerships to help out during large scale events?</li> <li>• How have you creatively managed equipment during large scale events?</li> </ul>	<p>KY-Outsourcing - Practices and Procedures</p>
Training challenges	Discussion Questions	State Information
<ul style="list-style-type: none"> <li>• Training; Training and information to and from equipment operators</li> <li>• Training of proper techniques</li> <li>• Keeping in-house, contract &amp; amp</li> <li>• Volunteer staff trained in winter maintenance</li> </ul>	<ul style="list-style-type: none"> <li>• Do winter maintenance trainees have a safe place to practice before hitting the road?</li> <li>• What kinds of materials (written and otherwise) are used to train new people?</li> <li>• Do you have dedicated staff that can provide training, or do current employees do this?</li> <li>• Is there a follow-up program for trainees to make sure they are performing well?</li> </ul>	<ul style="list-style-type: none"> <li>• AZ-Experience with our training simulators</li> <li>• IL-Joystick controls</li> <li>• IL-Installation of brine making systems capable of blending multiple chemicals</li> <li>• IA-Winter training program - modular system</li> <li>• KY-Outsourcing - Practices and Procedures</li> <li>• MN-Maintenance Training (SPOT, simulator, environmental training &amp; core training)</li> <li>• NY-Equipment Operator Training Program</li> <li>• UT-Plow Driver Simulator training</li> </ul>

TRACK THREE		
	<i>Moderator: Eli Cuelho</i>	<i>Facilitators: Diana Clonch, Lee Smithson</i>
Communicating to crews	Discussion Questions	State Information
<ul style="list-style-type: none"> <li>• Feedback to maintenance crews regarding performance</li> <li>• Communication of best practices to other garages in the state</li> </ul>	<ul style="list-style-type: none"> <li>• Do you have regularly-scheduled performance reviews?</li> <li>• Are there any incentives offered to good performers?</li> <li>• How is information disseminated throughout your district? state?</li> <li>• How do policy changes get communicated to others throughout your state?</li> </ul>	<ul style="list-style-type: none"> <li>• NY-Equipment Operator Training Program</li> <li>• IA-Winter training program - modular system</li> </ul>

TRACK FOUR		
<i>Moderator: Chris Strong</i>		
<i>Facilitators: Tina Greenfield, Dennis Belter, Pat Kennedy</i>		
Weather and Forecasting	Discussion Questions	State Information
<ul style="list-style-type: none"> <li>• Predicting the start of a winter storm</li> <li>• Weather and pavement forecasting</li> <li>• Implementing MDSS</li> <li>• Weather forecasts for accurate starting and ending times for winter storms</li> <li>• Freezing rain</li> <li>• Rain prior to frozen precipitation</li> <li>• Missed forecasts</li> <li>• Drifting snow</li> <li>• Predicting and warning for intense storms in limited areas</li> </ul>	<ul style="list-style-type: none"> <li>• What are the main challenges in road weather forecasting? (e.g. event timing, pavement temperature, microclimates)</li> <li>• Where does more effort need to be put into forecasting accuracy: avoiding false positives (predicting a storm that doesn't occur) or avoiding false negatives (a storm occurs "by surprise")?</li> </ul>	<ul style="list-style-type: none"> <li>• KS-MDSS</li> <li>• KY-RWIS System - Developed In-House</li> <li>• ME-Working with NWS</li> <li>• NE-Non-contact friction sensor for FAST activation</li> <li>• ND-MDSS, AVL, Incorporating Highway Performance Classification System into Snow &amp; Ice Control</li> <li>• UT-Fog dispersal</li> <li>• UT-RWIS communications</li> <li>• WA-Challenges of snow and ice operations in Washington's different climatic zones.</li> <li>• WA-Avalanche control operations on the passes in the Washington Cascade's.</li> </ul>
Consistency	Discussion Questions	State Information
<ul style="list-style-type: none"> <li>• Consistent use of chemicals and plowing techniques</li> <li>• Level of service consistency along a corridor</li> <li>• Implanting strategies statewide (i.e. Anti-icing, applications rates)</li> <li>• Uniformity</li> <li>• Encouraging use of anti-icing statewide (currently limited areas)</li> </ul>	<ul style="list-style-type: none"> <li>• What is the goal of consistency in maintenance practice; what problems are trying to be avoided?</li> <li>• What are the sources of inconsistency in maintenance practice?</li> <li>• How do states create consistency in maintenance practice? (rules of practice, training)</li> </ul>	<ul style="list-style-type: none"> <li>• IL-Installation of brine making systems capable of blending multiple chemicals</li> <li>• KY-Outsourcing - Practices and Procedures</li> <li>• NH-I-93 salt brine program</li> </ul>
Data collection	Discussion Questions	State Information
<ul style="list-style-type: none"> <li>• Collection and evaluation of winter data</li> <li>• Accurate data collections and reporting in winter operations</li> <li>• Road condition data gathering and reporting</li> </ul>	<ul style="list-style-type: none"> <li>• What types of data are collected on winter maintenance operations now? How should this be different 5 years from now? 10 years from now?</li> <li>• How are data on winter maintenance operations being used on a real-time basis?</li> </ul>	<ul style="list-style-type: none"> <li>• IN-AVL Project</li> <li>• KY-Outsourcing - Practices and Procedures</li> <li>• ME-WiFi data download from ground speed control</li> <li>• MN-Winter Pilot Projects - reducing application rates, Metropolitan Winter Operations, Anti-icing Program, and AVL Efforts</li> <li>• NB-Snowplow Management</li> </ul>

TRACK FOUR	<i>Moderator: Chris Strong</i>	<i>Facilitators: Tina Greenfield, Dennis Belter, Pat Kennedy</i>
	<p>How should this change over the next 5 to 10 years?</p> <ul style="list-style-type: none"><li>• How are data on winter maintenance operations being used on an archived basis? How should this change over the next 5 to 10 years?</li></ul>	<p>with AVL</p> <ul style="list-style-type: none"><li>• NY-Progressing the use of AVL in conjunction with moss</li></ul>