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Federal Highway Administration

Winter Maintenance Technical Peer Exchange

March 21-23, 2005 Harrisburg, PA

A Final Report

summarizing this Exchange, the background and purpose, description and agenda, the participants, the discussions, results and recommendations, and participant comments on the experience.

Hosted by
Federal Highway Administration
and the
The Pennsylvania Department of Transportation

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ACKNOWLEDGEMENT

We, the participants of the Winter Maintenance Technical Peer Exchange, would like to dedicate this report to all the State and local governments across the United States who deal with winter operations for our transportation systems, in hopes that sharing our experience will help to enhance your efforts in providing efficient, effective, and safe winter maintenance services.

We would also like to profoundly thank our respective organizations and the Federal Highway Administration for making this Technical Peer Exchange possible.

In addition, a special appreciation is given to the Pennsylvania Department of Transportation, Bureau of Maintenance and Operations, for championing this project and the FHWA Pennsylvania Division Office for nominating this project under the FHWA Technology and Innovation Program.

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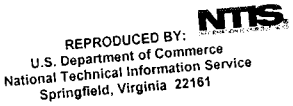

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16. Abstract

The Commonwealth of Pennsylvania, working closely with FHWA, took the lead in hosting the first Winter Maintenance Technical Peer Exchange. Pennsylvania, with one of the largest winter maintenance organizations involving state and local governments, has identified winter operations as a key to an effective, efficient and safe transportation system, enhancing the mobility and economic stability of the Commonwealth and the nation. The purpose of this multi-partner exchange was to improve the dissemination and use of winter technology for state and local governments and to help guide key transportation committees, organizations and associations addressing winter maintenance issues that effect transportation mobility, productivity, safety and the environment - four items directly related to FHWA's National Strategic Goals.

The Winter Maintenance Technical Peer Exchange was an intense 2 ½ day exchange with Technical Experts from across the country representing LTAP/T2 Centers, State DOTs, and FHWA. The exchange was geared toward improving winter maintenance training, technical assistance, and knowledge resources; the identification of technology development needs; and the improvement of critical methodologies and networks (e.g. T2/LTAP). This technical exchange explored winter maintenance technology addressing operations, materials, equipment, planning, and communications with respect to safety, the environment, and traffic mobility. The Exchange took place in Harrisburg, Pennsylvania from March 21 to March 23, 2005.

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Winter Maintenance Technical Peer Exchange

Introduction:

On March 21 to 23 of 2005, the Commonwealth of Pennsylvania through the Pennsylvania Department of Transportation (PennDOT) Bureau of Maintenance and Operations, working closely with the Federal Highway Administration (FHWA), the National Local Technical Assistance Program Association (NLTAPA), the Indiana University of Pennsylvania, the Pennsylvania State University, and the Salt Institute (a NLTAPA Partner), hosted the first national **Winter Maintenance Technical Peer Exchange.**

This report summarizes this Technical Peer Exchange, the background and purpose, a description and agenda, the participants, the discussions, results and recommendations, along with participant comments on their experience.

Background and Purpose:

What is a Winter Maintenance Technical Peer Exchange? It is a peer exchange for winter maintenance technical personnel or specialists specifically geared toward the exploration of winter operations and safety training, technical assistance, knowledge resources, new technical developments, and the improvement of critical winter operations methodologies and networks.

With the need for better sources of information and more exchanges among technical personnel (T2 Specialists) identified at the 2001 NLTAPA Annual Conference in Florida, Pennsylvania LTAP (PennDOT and Penn State University) hosted the first "technical peer exchanges" in 2002. These sessions, one on Highway Maintenance and one on Highway Safety, were a great success in increasing T2 networking, identification of useful technology sources, and improved training and technical assistance techniques; along with meeting the LTAP Strategic Plan.

Now again, the Commonwealth of Pennsylvania took the lead in hosting the first Winter Maintenance Technical Peer Exchange. Pennsylvania, with one of the largest winter maintenance organizations involving state and local governments, has identified winter operations as a key to an effective, efficient and safe transportation system, enhancing the mobility and economic stability of the Commonwealth and the nation. The purpose of this multi-partner exchange was to improve the dissemination and use of winter technology for state and local governments and to help guide key transportation committees, organizations and associations addressing winter maintenance issues that effect transportation mobility, productivity, safety and the environment - four items directly related to FHWA's National Strategic Goals.

Exchange Description:

The **Winter Maintenance Technical Peer Exchange** was an intense 2 ½ day exchange with Technical Experts from across the country representing LTAP/T2 Centers, State DOTs, and FHWA. The exchange was geared toward improving winter maintenance training, technical assistance, and knowledge resources; the identification of technology development needs; and the improvement of critical methodologies and networks (e.g. LTAP/T2). This technical exchange explored winter maintenance technology addressing operations, materials, equipment, planning, and communications with respect to safety, the environment, and traffic mobility.

The Exchange took place in Harrisburg, Pennsylvania beginning at 8:00 AM on Monday, March 21 and adjourning at 11:30 AM on March 23, 2005. In responding to the request for participation, the participants committed themselves to the following activities and tasks:

1. Attend and participate in the full two and one half day technical peer exchange.
2. Actively participate in development of the exchange's agenda, suggesting topics, procedures, activities, goals, etc. This activity commenced upon selection so that a final agenda could be prepared in advance of the exchange.
3. Actively participate in all planned group meals, including the evening dinner of the first day.
4. Prepare and submit written reports as assigned on specific topics covered during the exchange, and report on personal experiences as a participant in the exchange, for inclusion into a final report. Review and comment on the final report.

Exchange Agenda:

The selected participants developed the agenda through emails prior to the exchange. The agenda appears as Appendix A-1. A review of this agenda verifies the use of the word "intense" as used in the description of the exchange herein above.

Please note two additional things:

First, item A.d. Expectations pursued participants' expectations for the exchange leading into item B to establish and confirm the exchange goals, and then to Item C to review, revise and finalize the agenda with some time guidelines. The feeling was that it was important to establish common ground as a group from the start before tackling the identified topics.

Second, there was an effort made to solicit input from other major winter maintenance technical peers who could not attend the exchange. For example, item D.d.iv.1 introduces remarks from Bruce Drewes, Training and Research Manager, Idaho Technology transfer Center. The participants brought comments

and issues from various other sources to the exchange in order that this group might discuss and address as many national major concerns that could be identified.

The Winter Maintenance Technical Peer Exchange:

The exchange was held at the Wyndham Harrisburg-Hershey Hotel, Harrisburg, PA March 21-23, 2005

Copies of the schedule/agenda were distributed and reviewed.

Introductions were then made with everyone sharing personal biographical information along with data on their respective organization.

The following is a list of the Peer Exchange Participants, listed as to their respective organization (See Appendix A-2: Participant List for Winter Maintenance Technical Peer Exchange for more detailed information on the participants):

- **FHWA**
  Mark Sandifer, Technology Deployment Specialist, Resource Center
  (past Director of Colorado LTAP)
- **PennDOT**
  Alfred Uzokwe, Manager, New Technology Implementation Section
  Mike Hammond, Assistant County Maintenance Manager
- **Salt Institute**
  Richard Hanneman, President
- **IowaDOT**
  Dennis Burkheimer, Winter Maintenance Administrator
- **Cornell Local Roads Program (New York LTAP)**
  Duane (Dewey) E. Amsler, Sr. P.E., Consultant
- **Maryland T2 Center**
  Ed Stellfox, Center Manager
- **West Virginia Technology Transfer Center**
  Michael Blankenship, Program Manager
- **New England LTAP Centers (CT, MA, ME, NH, RI, VT)**
  Paul G. Brown, Consultant/Instructor
- **New Hampshire T2 Center**
  David H. Fluharty, Director
- **Virginia T2 Center**
  Russell Neyman, Program Manager
- **Wisconsin LTAP**
  Don Walker, Co-Director
- **Penn State University, Institute of State and Regional Affairs**
  Alan L. Gesford, Technology Transfer Specialist

The group then proceeded to traipse through the agenda, discussing the major areas or topics, going around the table for input followed by general questions, comments, and further discussion. From the very beginning introductions of self and organization and throughout the exchange, there was a profusion of knowledge, experience and understanding, leading to significant open discussion.

The agenda generated such a volume of discussion that could have resulted in a continuance over several weeks. In other words, time was of the essence and the group had to decide to concentrate on results that could be quantified into a report to substantiate the mission and goals of this exchange.

Therefore, for this report to accomplish its mission of providing the significant results of a technical peer exchange, the remainder of the report deals with the outcome of the voluminous discussions that took place by describing major "Discussion Items" that provide significant information for State and local governments and organizations involved in winter maintenance operations and then zeroing in on the last section of the agenda relating to the "Action Items" that were developed or recommended for future development.

Following the Action Items is a list of additional resources on winter maintenance identified by the group during the exchange discussions.

Discussion Items:

The exchange group considered certain discussion items as significant information to warrant inclusion into this report. Volunteers from the exchange group took the lead in drafting the respective items for this final report, which were then reviewed by the exchange participants. The items, with the lead person(s) identified, are as follows:

1. **Appropriate Winter Operations Policies and Strategies** (Dave Fluharty, New Hampshire LTAP). State and local government organizations need to develop appropriate policies and strategies to meet their winter maintenance responsibilities within the budget constraints and their residents' expectations. Appendix B-1, Winter Operations Policies and Strategies is an example that an organization can use as a guideline in developing their program.

2. **Winter Maintenance Training Options** (Don Walker, Wisconsin LTAP). When it comes to winter maintenance training, local governments need to consider the different options that are available. In order to help in that consideration the following recommended options and suggestions are offered:

   Training state and local personnel for effective winter maintenance operations requires an annual effort. New employees need an orientation and continuing employees need a refresher. In addition, new ideas should be evaluated and improvements incorporated in future operations.

An experienced trainer is a valuable resource for every agency. The question of who can we get to fill this need is often asked. There are several options to consider. An in-house trainer can be less expensive and able to fit the schedule of your agency. If the size of your agency or skills of your staff do not allow this option, then outside resources are needed. The best place to seek outside training is your state LTAP Center.

Updating or initial training for your trainers is also a need. The following three options can be considered.

1) Hire an outside trainer to come in and do the training. Again your LTAP Center is a great place to start the search. Here are a couple of tips. Be sure the person coming in to train has both the demonstrated teaching skills and technical background to do the job. Ask for references and check them out. Avoid people interested in selling something. Many vendors and consultants can do a good job, but they need monitoring. Also spend enough time telling the trainer who is in the group, what is your current practice and what if any point you want to make. Finally, set up the training so the participants feel it is a special event and you expect them to get a lot out of it. Avoid the attitude this is something you have to do because they don't do a good job, etc.

2) Train your own trainer. Hire an outside trainer. Ask him to not just teach the session, but also teach your staff how to do it themselves. Let your staff work along with the trainer during preparation and during the presentation as appropriate. This will allow the trainer to work in agency specific information and improve the end results. Expect this to require more time for the trainer, so it may require more compensation, but the pay off in future training efficiency will be worth it.

3) Send your trainer to other workshops. Invest in some training for your trainer. The new material and experience will pay off in better training results for your staff. If your trainer is not experienced, then have him talk to the outside workshop trainers ahead of time. In most cases they will be willing to spent extra time with him to provide tips, and training resources. If not, then select other training workshops.

In conclusion, you should get a significant return on your training investment. However it does take an investment including planning and support by management.

3. **"Winter Storm Scenarios" for Group Work Sessions** (Alan L. Gesford, Penn State University). Another item regarding training was the use of "Winter Storm Scenarios" for group problem solving. Some trainers are already using this technique and, thereby, scenarios have already been developed. The group decided there was a need to share this existing information with each other and with the LTAP centers. The collection of these shared scenarios could be handled

through a new winter maintenance electronic mail listserve (See Action Item 12) and be made available through the APWA LTAP Clearinghouse or through the Salt Institute.

4. **Effective Use of the Salt Institute's Website as a "Clearinghouse" Resource for Winter Operations** (Richard Hanneman, Salt Institute). The group discussed available online resources and agreed that the Salt Institute's website (http://www.saltinstitute.org) is the single best starting point for winter maintenance training professionals.

   Though a vendor site, the website is broadly comprehensive, has achieved a commendably objective presentation of materials and contains a useful summary overview of winter maintenance (http://www.saltinstitute.org/30.html). This page also functions as a portal with links to various further substantive internal pages and a vast number of other organizations' websites (including NLTAPA's) and online research reports. The overview includes summary discussions of the value of winter maintenance and how agencies address the environmental challenges of properly managing salt.

   The site also provides a place to download or order free copies of the Institute's numerous publications on winter maintenance (http://www.saltinstitute.org/34.html). These are the "public" pages on winter maintenance. The website also has a "snowfighting" section for LTAP trainers (http://www.saltinstitute.org/snowfighting/ltap.html) and snowfighting professionals. This section of the website provides free downloads of four of the five PowerPoint training presentations produced in partnership with NLTAPA as well as related handout materials. The fifth PowerPoint, containing embedded video clips making it too long for download, even with a broadband connection, has been distributed on CD to each LTAP Center and to the LTAP Clearinghouse; additional copies from the Salt Institute cost $20.

   The group agreed that trainers should make the Salt Institute website their jumping-off point in identifying training materials or researching questions on winter maintenance.

5. **LTAP Centers Need to Play a Better Role in Fostering DOT-Local Government Sharing of Winter Maintenance Resources** (Don Walker, Wisconsin LTAP; Dennis Burkheimer, Iowa DOT). LTAP Centers in the snowbelt states are encouraged to provide training and technical publications for local agencies on the topic of Snow and Ice Control. Winter road maintenance can make up as much as 1/3 of a local road agency. Even where winter storms are infrequent, the occasional storm will cause serious safety concerns, and disruption concerns.

   There are well developed training materials, publications, and newsletter articles by several of the LTAP Centers. This Peer Exchange project developed several

products of use to LTAP Centers including an example of a winter maintenance training outline (See Appendix C-1, Essential Topics for comprehensive winter Maintenance Training).

An additional valuable resource for each LTAP Center is their state DOT maintenance staff. In many cases the state DOT staff is facing reduced resources to handle their own responsibilities. Therefore, they may not be proactive in offering assistance to their LTAP Center. The Peer Exchange group suggests that it is the responsibility of the LTAP staff to make the contacts and request specific assistance. Even if DOT staff are not available to do training, they have many valuable resources they can provide without a large expense of time and cost. These include:

a) Status report on current DOT winter maintenance strategies: i.e. chemicals being used or evaluated and changes in equipment or policies.

b) Results of their relevant research and product evaluations.

c) Status and availability of (RWIS) weather information.

d) Training materials for DOT staff and coordination with state wide conferences etc

e) Snow Plow rodeo materials.

f) Current public relations/information efforts and materials

g) Status of pending or recently adopted regulations impacting winter maintenance.

h) Additional suggestions for cooperative efforts related to winter maintenance.

Do not overlook the opportunity to offer access to LTAP resources. Cooperative training can offer cost saving to both agencies. The point is to start and continue to cooperate with your DOT staff. This cooperation can be worth more that the direct DOT funds provided to LTAP. The responsibility for better cooperation and coordination between state DOT staff and LTAP belongs to the LTAP Staff.

With dwindling resources, state DOT's should look at LTAP centers as potential resource centers for training information and materials or partners to help develop training programs for use by all public agencies responsible for snow and ice removal in the state. Collaborating on training may lead to collaboration in other areas of snow and ice operations that would benefit all parties, reduce duplication of effort and provide more efficiencies in government.

The public is typically not aware of which agency is responsible for clearing the roadways they drive during a winter storm and it is in the best interest of all agencies to work together to make sure the public can reach their ultimate destinations safely irregardless of the roadway they use. Having the ability to drive safely on the Interstate for 40 miles is not likely to be of much help to a motorist that has an additional 10 miles of travel on an ice covered roadway before they reach their final destination.

6. **Understanding Abrasives** (Don Walker, Wisconsin LTAP). Abrasives play an important role in snow and ice control operations throughout the United States. Research and practice clearly indicate that abrasives can improve traction on icy or snow-covered roads. Unfortunately, abrasives are poorly understood and often misused, resulting in wasted material and money, and reduced safety for the traveling public. Appendix B-2, The Truth about Sand and Salt for Winter Maintenance, is intended to help agency managers think about their abrasive policies and practices.

7. **Legal Issues and Risk Management** (Duane Amsler, Cornell Local Roads Program). The exchange group discussed the impact of legal actions in the form of tort claims and others that are prime to winter operations. The following compilation provides the types of laws associated with local government snow and ice control operations.

   Most states have bodies of law similar in title to those below. The essential content of those laws is remarkably similar from state to state. Snow and ice control personnel should be aware of individual provisions of those laws in their state, and how they impact their operations.

   Vehicle and Traffic Law: In general, snow and ice control operations are usually exempt from the provisions of the Vehicle and Traffic laws. However, any instances of non-compliance must be OPERATIONALLY NECESSARY and be done ABSOLUTELY SAFELY. There may be civil liability in the event of an incident or accident.

   Most states have weight limits for commercial vehicles. In many states, these weight limits are modified or exempted for snow and ice control operations.

   Federal Commercial Driver License (CDL) Law: The provision of this law that is highly debated is the requirement for significant rest after 10 hours of operation. Many states do not believe that the provisions of this law are applicable to municipal operations as they are not involved in "interstate commerce". It is advisable to cooperate with your State Police on policy and procedures. However, it makes good sense to have a reasonable 'hours of operation' policy.

   Public Officers Law: Provisions of this law indemnify municipal workers from legal actions against them while performing their duties as a municipal employee.

In order to receive this indemnification, the employee must have been acting within the scope of his or her official duties and not broken a law.

Insurance Law: There are provisions in this body of law to protect municipal and commercial drivers from having their personal automobile insurance rates impacted by accidents that may have occurred while using municipal or commercial vehicles in the course of their employment.

Highway Law: Areas of interest in this law relating to snow and ice control operations are mailboxes and debris on the highway. The placement of ANY material (including snow and ice) on a highway is in violation of this law. This can be used to deal with people who place snow and ice from their driveways back on to the highway. Mailboxes are placed in the right of way at the municipality's discretion. Municipalities, working with the U.S Postal Service, have the authority to institute standards for placement in terms of location and structure. It is important not to create obstacles for snowplows and the traveling public.

Tort Liability: A tort is a civil wrong for which a court will award monetary compensation for damage (property, personal injury or death). Liability is legal responsibility for a tort. Municipalities are often sued for damage resulting from accidents involving snow and ice conditions on highways and other facilities There are a number of things a municipality can do to minimize snow and ice tort liability:

Have a written, reasonable level of service plan and policy that is consistent with available resources.

- Define what is to be done, where, when and under what conditions
- Define exceptions in terms of extraordinary weather and road conditions, lack of resources, etc.

Adhere to the policy.

Document in writing any deviation from policy, the reason(s), and what actions were taken to deal with the problem(s).

Document all snow and ice control operations in writing – what was done, where, when, etc.

Have a complaint/dangerous condition notification system that includes an action procedure and customer follow-up.

Be aware of recurring problem areas. Include how and when they are to be treated in your written plan.

All agency people should be provided with training on snow and ice control policy and practice to the extent possible.

8. **Implementing New Technologies** (Alan L. Gesford, Penn State University). Although you can never be all inclusive, one might say that most everyone would agree that winter maintenance is important and is a major factor in time, effort and costs for any public works organization within the snowbelt. There are continuously new technologies being developed and adopted toward more efficient, effective, and safe winter operations. Many of these technologies are listed herein below under Action Item 11 (and Appendix C-2, Important Winter Maintenance Technologies), a list that was developed during the exchange by the participants. When it comes to implementing new technology, however, there are several potential roadblocks that can either result in failure or be hurdled with success.

   The acceptance of new technology does not occur naturally. It usually results from hard work with trials and errors. It is important to recognize this fact and to make every effort to develop information that is concise and understandable and to make sure the information reaches the appropriate people. Multiple channels of communication should be used to promote acceptance of any new technology. Never expect one report, one presentation, one telephone call, or one visit to accomplish everything. The process of gaining support for a project needs to be carefully conceived and carried out. Change does not come easily, but addressing two major factors from the beginning will substantially improve the process and progress. These two major factors are top management commitment and employee involvement. Human contacts are critical ingredients; and understanding the needs, limitations, and problems of these two groups is critical.

   The success of implementing new technology starts with persuading managers and elected officials of the need and benefit associated with the innovation. First, do your homework. Become as knowledgeable about the new technology as possible. Talk to other users about their experiences. Develop costs for initial investment and for the continued operation and maintenance. Prepare a list of benefits to the community. Know what problems you may encounter and how you might handle or solve them. There is a natural resistance to change for many reasons, and one of the major ones is when the reason for change is unclear. Ambiguity, whether about costs, equipment, jobs, etc. can trigger negative reactions.

   Although the new technology may increase your winter operations efficiency and effectiveness, your discussions with elected officials should be based in terms of cost savings, improved safety and reduced liability, and the value to their constituents.

To deal persuasively with decision makers, it is necessary to know and understand their interests and opinions. The following questions may be helpful in organizing your efforts:

Who are the key people to persuade? Who will make decisions about the new technology, funding, and how it is used.

What are these decision makers' current opinions toward your department and operations, particularly winter operations? Are they neutral, friendly, hostile or apathetic?

What is the most practical way to approach the decision maker? Are they highly formal people who want everything in writing and all appointments scheduled in advance? Or are they more flexible responding favorably to personal telephone calls and informal meetings?

Are they willing to take risks? If they are low risk takers, maybe a trial project on a small scale may gain approval, or favorable data from another local government who has already successfully implemented the technology.

Having upper level management support, however, is not enough for successful implementation. Maintenance personnel who will be involved in the implementation and use of the new technology need to be involved from the beginning. They need to understand the new technology and know its relevance to the operational needs and associated problems as users. Having a part in the decision making process of exactly what is being purchased or implemented guarantees a buy-in from maintenance personnel. That buy-in ties to improved willingness to make the implementation successful. An unwilling user can always find a way to make something fail. Involvement leads to acceptance.

In addition, by including your maintenance personnel from the start, you have mobilized their support to improve the use of the new technology, tapping the expertise of every individual. After all, they are the "maintenance experts" in their respective job positions.

Once the new technology is approved and implemented and has been in use, the issue of success is not complete. Evaluation and user feedback is necessary for further improvement. And follow-up reports on the benefits and advantages back to the decisions makers are necessary to substantiate complete success of new technology implementation.

9. **Fabric Roof Salt Storage** (Mike Hammond, PennDOT). Appendix B-3, Fabric Roof Salt Storage, describes PennDOT's alternative storage option as a substantial cost-savings project. Please note the recommendations near the end of the article – Choose a fabric that will withstand the weather extremes of your region, check to make sure there is a warranty on the fabric, and acquire repair kits for minor cuts or tears. As Mike puts it: "Fabric Buildings are definitely worth consideration as an economical storage option."

Action Items:

The exchange group considered the following Action Items as significant to warrant inclusion into this report. The Action Items are under three categories: Action Items developed by the participants during the exchange and recommended for immediate use by State and local governments; an Action Item recommended for development that has already been developed and implemented; and Action Items recommended for future development by others as may be appropriate. Volunteers from the exchange group took the lead in drafting the respective items for this final report, which were then reviewed by the exchange participants. The items, with the respective lead person(s) identified, are as follows:

Action Items Developed for Implementation: The group developed the following items during the exchange.

10. **Essential Topics for Comprehensive Winter Training.** One of the major items of discussion was the importance of winter maintenance training. From this discussion, the relevance of training content to the needs of the total operations became the significant factor. The group decided that there was a need for a comprehensive list of topics that could be used as a guide by an organization in setting up or developing their training sessions. The list developed by the exchange group is included herein as Appendix C-1, Essential topics for Comprehensive Winter Maintenance Training. The list is broken into major topic areas and includes a 'Key Audience' guide for each topic/subtopic. Three separate key audience groups are identified: the Operators group including operators and other crew members, the Supervisors group including first-line supervisors and crew leaders, and the Managers group including Road Superintendents, Public Works Directors and other managerial personnel. This key audience guide indicates the key personnel that need to have the appropriate knowledge regarding the listed topics and is not intended to exclude any personnel from receiving training on any or all topics listed.

11. **Important Technologies.** Another major item identified by the group was the importance of the technological improvements and innovations regarding winter maintenance operations, materials and equipment. To address this importance, the group developed a list of what was considered the most important technologies, provided as Appendix C-2, Important Winter Maintenance Technologies. Winter maintenance personnel, specifically managers and supervisors should have the knowledge and understanding of these technologies and should consider the appropriateness of implementation for more efficient, effective and safe winter operations. To address the budget and funding aspects for new technologies, the list is broken into three categories: Items that can be implemented with little cost in time or dollars, items that can be implemented with modest investment, and items that can be implemented with greater investment. The breakdown and terminology used was subject to much discussion and was the result of the

group's consensus. (Please note Discussion Item 7, Implementing New Technologies, hereinabove, for tips on implementation.)

Action Item Recommended – Already Developed and Implemented.

Before the Action Items Recommended for Development are addressed, it is noteworthy to call attention to one of those recommended items that has already been developed and implemented.

12. **Electronic Mail list for Winter Maintenance Trainers.** As a result of all the discussions regarding agenda items on resources and dissemination, communications, and training and technology transfer, one of the Action Items introduced by the group participants who are also part of the National LTAP Winter Maintenance Committee was an "electronic mail list for winter maintenance trainers. It was recommended that this listserve could be set up through the NLTAPA Winter Maintenance Committee by the New Hampshire LTAP similar to the T2All listserve already administered through the New Hampshire LTAP. The benefits of such an electronic mail list would stem from increased networking, sharing of training materials, identifying resources, and evaluating websites.

    The New Hampshire LTAP has subsequently implemented this item. All participants of the exchange group have automatically become subscribers. The listserve is identified as the WinOPs Trainers Electronic Mail List and already has several new subscribers. It is open to private and public trainers and others specifically interested in winter operations training. **There is no cost.**

    To subscribe, send a message in the following format:

    ```
    To: ListProc@lists.unh.edu
    Subj: subscribe winops.trainers [yourname]
    ```

    Leave the subject line blank, and insert your name for "[yourname]." The server will read you email address. If you have any problems, contact kclaytor@unh.edu.

Action Items Recommended for Development.

During the exchange, various items were identified and confirmed by the group that would be useful for State and local governments for winter operations. These identified needs are listed here as recommended for future development by whatever means or resources that may be available. It is the expressed hope of the Exchange Group that these needs, having been identified, will be addressed through future projects by associated winter operations organizations or groups. Further explanation or discussion of any of these items can be obtained by contacting the identified lead person. The following descriptions were written by the identified lead person with subsequent review by the exchange group.

13. **Model Winter Operations Plan for Local Government** (Alan L. Gesford, Penn State University). Although there are many local governments who have developed and implemented written winter operations plans, there are still many others that do not have a written plan. Whether small or large in size, whether rural or urban, every local government could benefit from a well-organized, well

thought-out written plan. A written Comprehensive Winter Operations Plan is more than just a snow route map; it is a comprehensive plan covering all aspects of winter operations.

What goes into a plan? Here's a suggested list of items that need to be addressed:

Level of Service
Areas of Responsibility
Winter Organization Chart
Public Policies
Storm Warning System
Snow Route Map
Personnel Policies
Employee Training Program
Employee Winter Safety Program
Material Policies
Equipment Policies
Operations Policies
Interdepartment Cooperation
Intergovernmental Agreements
Use of Outside Contractors and Contracts
Public/Media Relations

As you can see, winter operations are no simple task. Comprehensive planning and organizing is essential for success. A good written plan has many benefits from more effective and efficient operations to good public and media relations to enhanced risk management and reduced liability.

There is a definite need for a model plan that can be used by local governments, as a base for developing their plan to fit the agency's needs, resources and roadway environment. The model plan would contain suggested language covering all of the above items and could be developed on a "fill in the blanks" scenario. An accompanying questionnaire could be developed to help bring forth all appropriate aspects for a detailed tailored plan. There are some great resources that could be used in developing a model plan. Several of these resources were shared at the exchange:

a. Snow and Ice Control, CLRP Publication 00-2, Cornell Local Roads Program (New York LTAP Center) by Duane E Amsler, Sr., P.E.
b. The Snowfighter Handbook, Salt Institute

In addition, there are existing winter operations plans from various local governments that could also help in development of a model.

14. **Driver Education Program for Winter Driving** (Mark Sandifer, FHWA). The exchange group discussed the winter driving skills or lack thereof of the motoring public. This factor is a major safety problem resulting in a much higher accident rate. The development of a driver education program for winter driving was identified as a crucial need for winter road safety. A program would include

different facets involving various groups and organizations and target different age groups. The following are some aspects to be considered.

Most of the accidents that occur during the winter months are the results of excess speed for road conditions. A more aggressive winter driving program targeted at new drivers through high schools and private organizations that offer driver education will help make the drivers understand the importance of safe winter driving.

School career days could be an additional way of reaching out to teens about the hazards of winter driving before they are old enough to drive. Education at a young age can only benefit them as they grow up. Representatives from the National Safety Council, AAA and AARP could give presentations at career days about the cause and effects of winter driving. Although the AARP is geared more toward drivers over 50, they could be influential in teaching teens to drive defensively.

To reach the more experience drivers, an organization could provide a comprehensive winter safety training class that would contain classroom and hands on time in a simulator or on a test track. Completion of this course would entitle the driver to a discounted auto insurance rate.

Another factor in the wintertime accidents is the false comfort level or sense of security that the larger vehicles such as the SUV, four wheel drives and ones with a high center of gravity give the driver. Time needs to be spent in driver education classes teaching the physics and functioning capabilities of the different vehicles in how they relate to various road conditions. A program could develop materials on winter driving that could be used by automakers to be given to new SUV owners.

The American Public Works Association (APWA) National Public Works Week could be used to promote the new education programs available and the importance of taking advantage of these programs.

15. **Operator Training Videos for Plowing Operations** (Mike Blankenship, West Virginia LTAP). In discussion of available winter maintenance training, it became evident that there was a need for up-to-date videos on plowing operations for operators. The following specific training video needs were identified:

Urban Plowing

Very few training videos are known to exist on this topic, and those that exist are dated. Operations that should be covered include plowing intersections, cul-de-sacs, around parked vehicles, steep grades (with and without parked vehicles), over and around traffic calming devices, curbs and fire hydrants, need for dry runs, recommended places to turn around, and roadside obstructions.

Local Rural Roads

Most training videos focus on open road plowing of state routes (freeways, wide shoulders, etc.). Videos on County and secondary routes are lacking. Operations that should be covered include staying on the road/in the lane, shoulder clean-up, steep grades, intersections, need for dry runs, recommended places to turn around, and roadside obstructions.

16. **Compendium of Resources on the Environmental Impacts of Winter Operations** (Paul Brown, New England LTAPs and Dewey Amsler, Cornell Local Roads Program). Environmental issues relating to winter operations are numerous. This is intended to highlight the issues that need to be identified to assure the balance of safe winter roads and the correct use and application of deicing materials. There is a significant need to collect into a single location the technical information available now.

    Discussions with the environmental people have proved very valuable. The perspective of the environmental agencies is typically significantly different from the highway agencies. The highway agencies are primarily concerned with safe roads and having adequate materials to complete the job at hand. Most environmental agencies would like to have reduced material use regardless. A good model in this regard is the recent Canadian legislation that requires salt management practices, but with safe roads being the top priority. Another issue is that there is a significant difference in technical information or laboratory results and real use application effectiveness. What is happening on the road may be the most useful of the information.

    In terms of chemical application rates, the results of NCHRP Project 6-13 as found in NCHRP Report 526 "Snow and Ice Control: Guidelines for Materials and Methods" provide the proper (that will produce a positive result in a couple of hours) salt application rates. These rates were derived from field data and take into account: pavement conditions, operational condition sand weather conditions. Using the suggested methodology will result in lower overall chemical loadings than most current practice for the same level of service goals. There is no similar body of work that defines abrasives and other chemical application rates in terms of pavement, operational and weather conditions. NCHRP Project 6-16 (see Appendix C-4, NCHRP Project 6-16) seeks to provide guidance for mitigating adverse effects of some of the commonly used snow and ice control materials. This project is currently underway and the project panel has approved an interim report.

    It would be a useful research project to find the best or most effective and environmentally safe use of chemicals, salt and abrasives. It would also be valuable to standardize the characterization of chemicals and de-icing materials in terms of performance effectiveness and environmental properties, not just the eutectic points. There is a void in our technical evaluation of materials due to this ambiguity.

The other significant concern is that the EPA and individual state environmental agencies do not always communicate on this issue. It would be useful to have a single authority for all environmental issues: human health; aquatic life; flora and fauna; surface-water and groundwater quality; air quality; vehicles; and physical infrastructure including bridges, pavements, railway electronic signaling systems, power distribution lines and other above and below ground utilities.

17. **Quantifying Benefits of Ground-Speed Controls** (Paul Brown, New England LTAPS). The use of Ground Speed Control has grown significantly over the last five (5) years and has provided a mountain of antidotal evidence of its value. From all outwardly evidence it is true, but, technically, there is not adequate evidence. It would be a benefit to both the industry and the end users, particularly State and local governments, if there was a formal technical research study of ground speed control and the benefits in material savings. Many manufacturers indicate the same 30% savings, but the question, "Where did this come from?" remains.

    Before it can be officially stated that ground-speed controls result in a 30% savings, the winter industry needs to back that figure up with real data. The manufacturers should be approached to provide funding for an independent research study to determine the factual savings.

    This task should be readily accepted within the industry in that a substantiated 30% savings by an independent research study could easily promote increased sales of the available systems. There are definitely enough existing systems in use that could be used in a research study to monitor and compare to manual systems under similar conditions, keeping the research project costs at a minimum.

18. **Salt Brine and New Chemical Research** (Dave Fluharty, New Hampshire LTAP). With the advance of anti-icing technology and the use of liquid salt, sodium chloride (NaCl) plus an array of new chemical mixtures on the market, the exchange group identified a need for research in the use of solid and liquid chemicals for anti-icing operations to determine factors for effective use, and the associated comparison costs and benefits, particularly for the use of sodium chloride in comparison with other chemicals. For a further detailed recommendation on conducting comparison studies, Appendix C-3, Salt Brine and New Chemical Research, provides a research design outline.

19. **National DOT Winter Maintenance Manager Meeting** (Dennis Burkheimer, Iowa DOT). Cities and Counties often learn about new technologies or practices in winter snow and ice removal operations through LTAP centers, the American Public Works Association (APWA) or other sources. Publications and seminars on snow and ice removal topics are available through these groups and every April the APWA also sponsors the North American Snow Conference that is held at different locations each year. The Snow Conference attracts over 1,000 attendees from all over the United States and provides a wide variety of

educational sessions on snow and ice removal topics along with vendor display areas to see and learn about the latest in equipment technology.

Training opportunities for State Departments of Transportation are typically developed in-house based on the state's respective needs or may include a joint training package developed through pooling funds with other states. A new computer based, interactive training program on Roadway Weather Information Systems (RWIS) and Anti-Icing was developed through pooling funds of several state agencies, the Federal Highway Administration (FHWA), the National Association of County Engineers (NACE) and the APWA and has become a popular training tool for field personnel. (See Identified Resources, Item c, herein below) Limited training is also available through the FHWA but is typically limited to training in RWIS or surface transportation weather topics.

State Departments of Transportation typically operate autonomously with regard to winter operations and little effort has been made to organize a group to focus on winter snow and ice removal issues at the national level. An annual meeting of State Maintenance Engineers is held by AASHTO each year, but snow and ice is only one of the many topics discussed at the meeting and of interest only to those with active winter snow removal operations. The FHWA has organized national efforts for RWIS and surface transportation weather but little has been done to coordinate efforts in related snow and ice areas such as materials, methods, equipment, etc. The Eastern Snow conference is supported by the FHWA but is typically limited to states on the East Coast due to travel and budgetary restrictions. Several areas of the country also have regional meetings where representatives of States Department of Transportation can share information about their operations and new technologies. Other pooled fund initiatives such as Clear Roads and Aurora have been created but their focus has primarily been on conducting research on snow and ice removal operations. Participation in these pooled fund efforts is also limited by state budgets.

It is recommended that the FHWA sponsor and financially support an annual meeting of snow and ice managers from each State Department of Transportation to share information about winter maintenance operations, learn about new research in the field, learn about new training tools and also develop a framework for a comprehensive national snow and ice removal strategy. This meeting would also cover best practices for sharing information, technology and training with other public agencies to help improve overall snow and ice removal operations for the traveling public. This meeting would help identify best practices in snow and ice operations and also create opportunities to work together on common problems. Estimated cost for a three day conference is approximately $40,000-$50,000.

Identified Resources: The exchange discussions resulted in identification of a variety of resources for winter operations. The following list describes those resources for State and local government use. The following descriptions were written by the identified lead person with subsequent review by the exchange group.

a. **NCHRP Projects** (Duane Amsler, Cornell Local Roads Program). The National Cooperative Highway Research Program has two projects, one active and one completed that have significant value for winter Operations. Project 6-16, Guidelines for the Selection of Snow and Ice Control Materials to Mitigate Environmental Impacts, provides guidelines, as the title states, for selection of chemicals and abrasives based on their constituents, performance, environmental impacts, cost, and site-specific conditions. (See Appendix C-4, NCHRP Project 6-16) The project panel has received and approved the interim report.

   Project 6-13, Guidelines for the Selection of Snow and Ice Control Materials and Methods, provides guidelines for selecting roadway snow and ice control strategies and tactics for a wide range of winter maintenance operating conditions. (See Appendix C-5, NCHRP Project 6-13) NCHRP Report 526 "Snow and Ice Control: Guidelines for Materials and Methods" contains the guidelines developed in the project.

b. **AASHTO Guide** (Duane Amsler, Cornell Local Roads Program). The AASHTO **Guide for Snow and Ice Control** presents a comprehensive overview of the components required for a successful snow and ice control program. It describes the purpose for snow and ice control and how to achieve an appropriate level of service. The guide discusses the importance of involving other jurisdictions, the media, emergency management services, and the public in developing policies and practices to provide the level of service.

   Document Number: AASHTO GSIC
   American Association of State and Highway Transportation Officials
   01-Jan-1999
   Order Printed Edition
   (English)
   $68.00 USD
   (Usually Ships From Techstreet In 3 - 5 Days)

c. **AASHTO CBT Program on Anti-icing and Road Weather Information Systems (RWIS)** (Dennis Burkheimer, Iowa DOT). Across North America significant improvements in winter maintenance have been taking place. Traditional roadway snow and ice control strategies are being revolutionized through the use of RWIS (Road Weather Information System) technology and anti-icing techniques. Training is key to the successful integration of these new tools into a winter maintenance program.

The AI/RWIS CBT is a self-paced, interactive multimedia computer-based training program that follows sound adult learning principles. The program requires interaction by the student beyond simply moving from one page to the next. Practice and review exercises, fun facts, and links to key word definitions, a glossary, a Knowledge Base and Internet sites add to the experience.

The actual training is divided into two parts. The first contains seven formal lessons that present the base of knowledge for RWIS and anti-icing. The lessons are:

- Introduction To Anti-Icing And Winter Maintenance
- Winter Road Management
- Roadway Ice And Winter Hazards
- Weather Basics
- Anti-Icing Road Weather Analysis
- Computer Access To Road Weather Information
- AI/RWIS Practice In Winter Maintenance

Once students complete all seven lessons and pass the quizzes, they find themselves in the scenario room where they can practice what they have learned. Faced with a variety of winter storms particular to their own region, students make decisions regarding chemical use and timing based on information from many sources. Detractors and distractions are also present in the scenario room to complicate the life of the student.

A suite of administrative tools (available on a separate CD) enables training managers to monitor student progress and performance as well as customize the course content to reflect unique needs and practices.

The development of this training program was made possible by the cooperation of SICOP, NACE, APWA, the AURORA Snow and Ice Consortium, and several participating governmental agencies through the AASHTO Pooled Fund program. The program is available through the APWA bookstore.

The program was designed to allow other training modules to be added in the future. A training module for deicing chemicals is currently in the works and other winter maintenance topics are being considered.

d. **Cool Video for Kids!** (Don Walker, Wisconsin LTAP). The video is titled "A Snowplow – Cool!". The video is an 8-minute lesson for second and third graders about safety around snowplows and the dangers of playing in snow banks. The video with a lesson plan and associated classroom and homework activities are the basis for a safety lesson about not building "forts" in the

snow bank at the curb, staying away from snowplows, and not sliding/sledding into the street. The video and worksheets should take approximately one-half hour of class time.

Local government public works departments are encouraged to have a snowplow visit the school and the driver present the video and lesson. Although this is not required for using the safety lesson, it will improve the retention of the lesson. Having children view the inside of the cab of the snowplow will expand the lesson time to a full hour.

The project is based on the experiences of snowplow drivers who have had a program for presenting snowplow safety in schools. The project was sponsored by the Minnesota Local Road Research Board, 651-282-2274 (or contact the Minnesota LTAP (www.mnltap.umn.edu or 612-624-3646. A great tool to further foster understanding of public works operations at an early age.

e. **Major National/Regional Winter Maintenance Events** (Mark Sandifer, FHWA):

APWA North American Snow Conference is held annually and designed to provide agencies with the skills and knowledge on how to improve an agency's winter maintenance program. The target audience is anyone who participates in the fighting of snow or ice. The conference disseminates this information through the use of exhibits, roundtable discussions, educational breakout sessions, hands on and networking. Participants attend from all across the United States and Canada. This conference changes locations each year. *For more information their website is www.apwa.net*

Western Snow & Ice Conference and National Snow Roadeo is hosted by the Colorado Chapter of the American Public Works Association (APWA). The goal of the conference is to inform and educate operators and mechanics, supervisors and managers who deal with snow and ice control and fleet maintenance. The program offers various topics which all agencies face at one time or another. The National Snow Roadeo is comprised of a serious of skill tests allowing agencies to compete against each other for recognition and bragging rights to the best winter road crew. Participants attend from all across the United States and Canada. This conference is always hosted in Colorado. *For more information their website is www.westernsnowandice.com*

Annual Eastern Winter Road Maintenance Symposium and Equipment Expo is hosted by FHWA, the host State DOT and Local Technical Assistance Program (LTAP) Center. This conference is targeted at Winter Maintenance managers and other public works practitioners from Cities, Townships, Counties, and States (as well as other public agencies and

private sector partners) east of the Mississippi River. Break-out sessions and round table discussions are just part of the format used as educational tools to disseminate knowledge, best practice and new technology information about snow and ice control. This conference changes locations each year. *For more information their website is www.easternsnowexpo.org*

Summary:

The Winter Maintenance Technical Peer Exchange was a first and was a success. If we can sum up a most general consensus, it's simply that more communication and networking is needed between all the organizations and people involved in winter operations. This Technical Peer Exchange initiated crucial networking on a national basis for winter operations that needs to continue through additional peer exchanges or through other snow-free roads in the future.

As part of this closing section, we refer you to the last Appendix D-1 for the participants' personal comments on their peer exchange experience.

Appendix

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Appendix A-1

Final Agenda

Winter Maintenance Technical Peer Exchange
March 21-23, 2005 Wyndham Hotel, Harrisburg, PA
FINAL AGENDA (Not set in stone, see Item C below!)

Monday, March 21, 2005

7:30 AM	Continental Breakfast
8:00 AM	Morning Session
10:00 AM	Morning Break
12:00 Noon	Lunch
1:00 PM	Afternoon Session
2:30 PM	Afternoon Break
3:45 PM	Break for Airport Tour
4:00 PM	Airport Tour
6:30 PM	Dinner

Tuesday, March 22, 2005

7:30 AM	Continental Breakfast
8:00 AM	Morning Session
10:00 AM	Morning Break
12:00 Noon	Lunch
1:00 PM	Afternoon Session
2:30 PM	Afternoon Break
5:00 PM	Adjourn
5:00 Pm	Meeting of the LTAP Winter Maintenance Committee

Wednesday, March 23, 2005

7:30 AM	Continental Breakfast
8:00 AM	Morning Session
10:00 AM	Morning Break
11:30 AM	Adjourn

Winter Maintenance Technical Peer Exchange Agenda

A. General Introductions:
   a. Sharing bios/experience and respective organization/agency info and activities
   b. Schedule Review for the 2 ½ day Exchange
   c. Housekeeping Items
      i. Expense Reimbursement Procedures
   d. Expectations -
   e. Questions & Answers

B. Establishing and confirming goals for the exchange
   a. To improve dissemination and use of winter maintenance technology for state and local governments
   b. To improve the effectiveness of winter maintenance training
   c. To identify key winter knowledge resources
   d. To identify winter technology development needs
   e. To expand LTAP/T2 winter technology transfer networks
   f. To develop recommendations to key organizations (AASHTO, FHWA, NACE, NLTAPA, APWA, etc.) with the purpose of helping to guide our key transportation communities, organizations and associations in addressing winter maintenance issues regarding:
      i. Transportation mobility
      ii. Productivity
      iii. Safety
      iv. Environment

C. Agenda Review - final revisions, set times

D. What's Existing and What's Needed?
   a. What is the present status of winter maintenance operations?
      i. Planning and Organizing
      ii. Materials
      iii. Equipment
      iv. Operations
   b. 'Are there' and 'what are' the differences geographically across the snowbelt states?
   c. Who uses and who doesn't use available technology?
      i. Why and why not?
      ii. Where are the gaps?
   d. What are the major challenges facing winter maintenance in terms of:
      i. Transportation mobility?
      ii. Productivity?
      iii. Safety?
      iv. Environment?
         1. Comment from Bruce Drewes, Idaho DOT: *In the West the transportation agencies have been taken to task about the way that they deal with snow. Here in Idaho we have two salmon and a sea run steelhead that are currently listed on the threatened or endangered lists. Due to the reduction of the salmon population in the Pacific Northwest, the state DOTs and the Local agencies are under the microscope when dealing with winter maintenance. The issue of sediment in the streams due to abrasives being applied to the roadways and the migration of chemicals into the streams are of major concerns for the Northwest.*
   e. How do agencies prioritize the incorporation of BMPs (In other words, what changes are likely to deliver the biggest bang for their bucks? If an agency isn't using ground-control automated spreaders or isn't calibrating or isn't doing worker training, the benefits of making these changes will be far more important and

cost-effective than investing in an RWIS station or buying infrared devices for their trucks to ascertain pavement temperatures.)

f. Recommendations for the future

E. What's New?
   a. What new technologies exist?
      i. Planning and Organizing
      ii. Materials
      iii. Equipment
      iv. Operations
   b. Are they meeting (or will they meet) our needs?
      i. Transportation mobility
      ii. Productivity
      iii. Safety
      iv. Environment
   c. Are new technologies being implemented?
      i. Why and why not?
      ii. At what rate?
      iii. Where are the gaps?
      iv. What do we recommend for the future?
   d. What are our future needs?

F. Resources and Dissemination
   a. What's available? Who has it? How does one get it?
      i. Organizations/Associations
      ii. Internet sites
      iii. Internet Groups
      iv. Training Resources
         1. List of Instructors
      v. Research
   b. Sharing of materials, examples, etc from the group:
      i. Wisconsin training materials
      ii. Cornell training materials
      iii. Municipal Snow and Ice Control Plan, Cranberry, PA
      iv. IDOT website
      v. AASHTO RWIS/Anti-icing program
   c. How are we disseminating this info?
   d. How can we improve?
      i. National Clearinghouse?
   e. Recommendations for the future

G. Communications
   a. DOT's – How do they communicate? How effectively?
      i. Within - Management/Engineering/Safety/Equipment/ Maintenance
      ii. With other DOTs

iii. With local governments
iv. How can we improve?
v. What are the gaps?
vi. How can we improve?
vii. Recommendations for the future

b. Local governments – How do they communicate? How effectively?
i. With each other?
ii. With the DOT?
iii. What are the gaps?
iv. How can we improve?
v. Recommendations for the future.

c. Communications with the public
i. Public Relations
1. Educating the public – can we help in training?
2. example: WM PR programs
ii. Media Relations
1. Can we help?

H. Training and Technology Transfer Issues
a. Winter Maintenance Technologies and Practices
i. What are we teaching?
ii. What should we be teaching?
iii. Who are we teaching?
iv. What kind of problems or concerns are we having?
v. How are we delivering to local agencies?
1. Classroom vs. other approaches
2. Class problems with demonstrations
3. Field demonstrations
4. Videos
5. Power Point Presentations
6. Computer Interactive
7. Technical Assists - Field Review
vi. Have we had successes?
vii. Are we seeing actual practices being implemented?
viii. Are we doing enough?
ix. To what extent are we involved in environmental areas?
1. Should we be doing more?

b. New technologies - keeping up with the information overload.
i. Are we able to keep up-to-date?
ii. How are we handling it?
iii. What can we do to improve the process?

c. Measured Results
i. Is technology being transferred and used?
ii. What are the roadblocks?
iii. What are we doing and what can we do to remove these roadblocks?
iv. Systematic testing of the extent & effectiveness of the work.

I. Closing Summary
    a. What have we learned?
    b. Discussion on needs and solutions
    c. Where do we go from here?
        i. Action Items to be Initiated
        ii. Action Items to be Implemented
    d. Final Exchange Report
        i. Participant's written comments
            1. Perspective on the Exchange
            2. Lessons learned
            3. Recommendations for future exchanges
        ii. Time line for report
    e. Final comments & adjournment

Appendix A-2

Participants List for Winter Maintenance Technical Peer Exchange

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Appendix B-1

Winter Operations Policies and Strategies

By David H. Fluharty, Director
New Hampshire T2 Center

Resident Expectations

During a typical winter storm, residents generally expect to drive on roads in certain condition. They also expect bare pavement within a certain period after a storm. Their expectations will vary across counties and municipalities, but residents will generally agree within a community. An agency's policy and strategy should result in its residents' generally expected road conditions.

Table 1 describes easy-to-understand definitions of residents' expectations. "LOS" is an acronym for "Level of Service" used in developing policies and strategies. The Table 1 expectations, and the strategies described below, are based on a "normal winter storm" defined as: A storm that is predominately snow and temperatures before and during the storm are above 10°F.

Table 1. Residents' Driving Expectations		
	Residents' Expectations	
LOS	**During a normal storm**	**After a normal storm**
High	Roads are passable, with occasional, short delays due to a general speed reduction	Bare pavement within 3 hours
Medium	Roads are passable but traveling speeds reduced and moderate delays due to reduced capacity	Bare pavement within 3 to 8 hours
Low	Roads are passable, but with reduced capacity and reduced traveling speeds, at times significantly with some severe delays	Bare pavement more than 8 hours
Unacceptable	Road temporarily closed.	Bare pavement within a day

Attachment 1, "Snow-Ice Treatment Effectiveness," (herein below) describes measures of road conditions. Table 2 ties those conditions to the Table 1 LOS for residents' expectations.

Table 2. During and After Normal Storm Conditions	
LOS	**Conditions and Residents' After-Storm Expectations**
High	Conditions 1 through 3 -- No bonded ice or snowpack during a storm
Medium	Condition 4 -- Some bonded ice or snowpack during a storm
Low	Conditions 5 and 6 -- Bonded ice and/or snowpack during a storm
Unacceptable	Condition 7 -- Surface completely covered with bonded snow or ice; significant build up and excessive unplowed snow

Policies and Strategies

Over the past two decades, research has provided road managers with methods to provide Table 2 conditions. Achieving those conditions will in turn fulfill the Table 1 driver expectations,

which should be an agency's winter operations policy. In other words, its policy should be in terms of Table 1 LOS. To achieve the Table 2 road conditions appropriate for that LOS, the road manager can apply the strategy indicated in Table 3.

Table 3 strategy definitions are:

- Anti-icing. Chemical application before and during the early stages of a storm (pretreating), and as necessary throughout the storm. Anti-icing prevents ice and snow pack from bonding to the pavement between chemical applications.
- Deicing. The application of chemicals after snowpack and/or ice has bonded to the pavement. Crews spread chemicals until the snowpack or ice-to-pavement bond is broken and they can mechanically remove the snow and ice.
- Mechanical. The removal of snow, ice, and water from roadways by conventional plows, rotary plows (snow blowers), brooms, and other mechanical equipment.

Anti-icing and deicing strategies include mechanical snow removal during and between chemical applications. If properly carried out, the strategies will achieve the indicated levels of service during a "normal winter storm" described below.

Table 3. Strategies to Achieve Residents' Driving Expectations

	Levels of Service			
Strategy	**High**	**Medium**	**Low**	**Unacceptable**
Anti-icing	X			
Deicing		X	X	
Mechanical only			X	X

Several publications describe the proper equipment and procedures to carry out each strategy. A directory of LTAP Centers is at http://www.ltapt2.org/centers/list.htm.

Prewetting is an important component of anti-icing when pavement temperatures are below 25°F. Highway agencies can prewet sodium chloride (NaCl) by one of three methods. The recommended method is to mount an on-board spray system on the spreader and/or the dump body and add liquid chemical to the dry chemical during spreading.

A "Normal Winter Storm"

Road managers should establish winter operations policies and strategies to provide specific road conditions for a "normal winter storm." The definition is repeated here for convenience: A storm that is predominately snow and temperatures before and during the storm are above 10°F.

There are several reasons for this definition. First, storms outside this definition seldom occur, so the agency can frequently fulfill the policy. Second, residents generally understand that they cannot reasonably expect passable roads during extreme storms, or bare pavement after in the Table 1 periods. Finally, anti-icing and deicing might not achieve the indicated LOS in the extreme situations described below. Road managers should describe these situations as exceptions to their agency's winter operations policies.

- Rain and very wet snow. Anti-icing and deicing depend on chemicals to melt snow and ice. Excessive moisture dilutes the chemicals, and often makes them ineffective in these conditions.
- Very cold temperatures. Anti-icing and deicing chemicals will melt ice when pavement temperatures are above about 10°F. At lower temperatures, chemicals melt too little ice to be

effective. Mechanical snow removal is the only viable strategy at very low temperatures. In these conditions, applying abrasive might be effective on low speed areas, such as at intersections and on hills and curves.

An agency's policy should also state that it applies to roads without excessive traffic. For effective anti-icing, crews must spread chemicals within the first several hours of a storm, and often during a storm. Heavy traffic can inhibit spreading chemical within the necessary periods. Heavy traffic can have similar effects on deicing.

The Most Desirable Strategy: Anti-icing

As shown in Table 3, anti-icing is the only strategy that will reliably achieve a *High* level of service. Referring to Tables 1, anti-icing will meet the highest reasonable resident expectations during and after normal storms. In summary, anti-icing will provide:

- No bonded ice or snowpack during a storm.
- During a storm, passable roads with occasional delays due to a general speed reduction.
- Bare pavement within 3 hours after a storm.

In addition, chemical applications are much less for anti-icing than for deicing, which reduces both costs and environmental impacts. Most agencies have the equipment necessary to apply solid NaCl, which is the most used chemical for anti-icing. Many have the equipment to prewet the solid NaCl to make the combination effective between 10 and 25°F. Calibrating equipment will ensure that equipment will spread only the necessary chemical, and save money. Ground speed control will save even more.

Deicing and Mechanical Only

Some counties and municipalities have historically established a *Medium* or *Low* LOS, and residents have come to expect that level of service. In such situations, an agency might have to consider a strategy other than anti-icing. If it has equipment sufficient only for that LOS, residents might resist paying for additional equipment to achieve a *High* LOS.

In addition, where plow routes are historically more than three hours, residents have probably become used to a *Medium* or *Low* LOS. Increasing the LOS to *High* will require shorter plow routes, and more operators and equipment. Effective anti-icing requires timely chemical applications. Operators on plow routes greater than three hours to complete can seldom spread chemical within the necessary timeframes. Residents might prefer the status quo rather than pay for the additional labor and equipment necessary for a *High* LOS.

Some might argue for *Medium* or *Low* LOS based on environmental concerns about sodium chloride. To accept a *Medium* LOS ignores the fact that deicing is necessary to achieve it, and that an agency will frequently spread more NaCl deicing than by anti-icing. If the residents accept a mechanical only strategy, and *Low* LOS, the agency will have to apply NaCl, or another chemical, to achieve a *High* level of service.

Abrasives

Many highway departments apply sand on snow and ice covered roads to increase friction and improve road safety. Yet, significant friction increases occur in only a few situations. One situation, as noted above, is when temperatures are extremely low. Several reliable sources describe other situations, but they are limited. (See http://www.sicop.net/Abrasives%20report.pdf)

Policy makers should also consider the major disadvantages of using abrasives. Abrasives do not melt ice or snow. They are expensive to purchase, store, spread, and clean up. Sand has air and water body environmental impacts. (See http://www.t2.unh.edu/fall01/pg6-7.html)

Perhaps most important, if the agency adopts a policy for a *High* LOS, and anti-icing to achieve it, residents can drive on bare pavements during normal storms and after in the periods described in Table 1. The agency would have to apply abrasives only when air or pavement temperatures are extremely low.

Conclusion

Winter operations agencies should establish policies in terms of the resident expectations described in Table 1. They should state the exceptions to a "normal winter storm," and to heavy traffic. They should then determine which Table 2 road conditions they should achieve, and apply the appropriate Table 3 strategy.

If the agency has the equipment necessary to apply an anti-icing strategy, there are numerous advantages for doing so. It can achieve a *High* LOS, reduce environmental impacts, and in most cases save money. Even if the agency must purchase some equipment, it should consider anti-icing to reap these benefits.

Agencies might have to apply a mechanic only strategy and use abrasives during extremely low temperatures. Anti-icing makes abrasive use unnecessary during normal storms.

Attachment 1: Snow-Ice Treatment Effectiveness

The key anti-icing effectiveness measure is whether snow or ice has bonded to the pavement. The following effectiveness measures emphasize bonding, and have additional criteria. They are adapted from "Table 1 -- Descriptions of pavement snow and ice conditions" on Page 4 of NCHRP Report 526, *Snow and Ice Control: Guidelines for Materials and Methods.*

Condition 1: All snow and ice are prevented from bonding and accumulating on the road surface. Bare/wet pavement surface is maintained at all times. No weather-related traffic delays other than those associated with wet pavement surfaces, reduced visibility, incidents, and "normal" congestion.

Condition 2: Bare/wet pavement surface is the general condition. Occasional areas have snow or ice accumulations resulting from drifting, sheltering, cold spots, frozen melt-water, etc. Prudent speed reduction and general minor delays are associated with traversing those areas.

Condition 3: Accumulations of loose snow or slush are on the pavement surface. Packed and bonded snow and ice are not present. There are some moderate delays due to a general speed reduction. However, the roads are passable at all times.

Condition 4: The pavement surface has continuous stretches of packed, bonded snow with or without loose snow on top of the packed snow or ice. Wheel tracks may range from bare/wet to slush or unpacked, unbonded snow. On multilane highways, only one lane will exhibit these pavement surface conditions. There is a reduction in traveling speed and moderate delays due to reduced capacity. However, the roads are passable.

Condition 5: The pavement surface is completely covered with packed, bonded snow and/or ice. There may be loose snow on top of the packed surface. Traveling speed is significantly reduced and there are general moderate delays with some incidental severe delays.

Condition 6: The pavement surface is covered with a significant buildup of packed, bonded snow and/or ice. There may be loose or wind-transported snow on top of the packed surface due to high snowfall rate and/or wind. There may be deep ruts in the packed snow and ice that may have been treated with chemicals, abrasives, or abrasives/chemical mixtures. Travelers experience severe delays and low travel speeds due to reduced visibility, unplowed loose, or wind-compacted snow, or ruts in the packed snow and ice.

Condition 7: The road is temporarily closed. This may be the result of severe weather (low visibility, etc.) or road conditions (drifting, excessive unplowed snow, avalanche potential or actuality, glare ice, accidents, vehicles stuck on the road, etc.).

Condition	Bonded Snow/Ice	Accumulation	Traffic Delays
1	No bonded snow or ice	None	None except those associated with wet pavement surfaces, reduced visibility, incidents, and "normal" congestion
2	No bonded snow or ice	Occasional areas having snow or ice accumulations resulting from drifting, sheltering, cold spots, frozen melt-water, etc	Prudent speed reduction and general minor delays associated with areas of accumulation
3	No bonded snow or ice	Loose snow or slush on the surface	Moderate delays due to a general speed reduction; roads are passable at all times
4	Partial; no bonding in wheel paths	Stretches of bonded snow pack. Wheel tracks range from bare/wet to slush or unpacked, unbonded snow	Roads are passable but traveling speeds reduced and moderate delays due to reduced capacity
5	Yes, surface completely covered with bonded snow or ice	May be loose snow on top of the packed surface	Traveling speeds significantly reduced and general moderate delays with some incidental severe delays.
6	Yes, surface completely covered with bonded snow or ice; significant build up	May be loose or wind-transported snow on top of the packed surface and/or deep ruts in packed snow and ice	Severe delays and low travel speeds due to reduced visibility, unplowed loose, or wind-compacted snow, or ruts in the packed snow and ice
7	Yes, surface completely covered with bonded snow or ice; significant build up	Severe weather, drifting, excessive unplowed snow	Road temporarily closed

Appendix B-2

The Truth about Sand and Salt for Winter Maintenance

By Donald Walker, P.E.
Professor Emeritus, University of Wisconsin-Madison
Director, Wisconsin Transportation Information Center/LTAP

Abrasives play an important role in snow and ice control operations throughout the U.S. Research and practice clearly indicate that abrasives can improve traction on icy or snow-covered roads. They can be a very effective treatment in environmental and temperature conditions where deicing chemicals don't work. In addition, abrasives can be used to maintain safety at hills, curves and intersections on unpaved and low volume roads. Using chemicals on unpaved roads is ineffective and damages the surface, while many low volume roads do not merit the level of service provided by chemicals.

Unfortunately, abrasives are poorly understood and often misused, resulting in wasted material and money, and reduced safety for the traveling public. The following discussion is intended to help agency managers think about their abrasive policies and practices.

How they work

First, let's be clear about how salt and abrasives work. Salt melts snow and ice.
The best uses of salt and other deicing chemicals are to prevent ice from bonding to the pavement and to aid in removing it from the pavement once it is stuck there.

Plowing, when it can be done, is by far the best winter maintenance tool. Nothing is more effective than plowing to remove snow and slush from the pavement. However, many storm conditions develop that make it difficult or impossible to prevent snow pack or ice from developing on the pavement. This is where a deicing chemical is needed if you want to quickly restore clear pavement conditions. Salt melts snow and ice so we can plow the pavement clear.

What do abrasives do? They increase friction, providing better traction and control for vehicles. Abrasives do not melt snow and ice. An inert piece of stone or slag will not melt anything!

Furthermore, for an abrasive to actually improve traction it must remain between the tire and the ice. It does no good when it is buried in the snow or is blown off the pavement. Research has shown it is difficult to maintain good traction with abrasives when there is any significant traffic. Vehicle traffic tends to work the abrasive into the snow and/or pick it up in the tires and blow it off the pavement. A paper by Professor Wilford Nixon has a good discussion of the research relating to abrasives testing (1).

Do abrasives have much real value in promoting safety? Yes, because abrasives are often the only reasonable option we may have. Low temperatures or freezing rain conditions, for example, limit the effectiveness of chemicals. However, abrasives are far from efficient as a method for

snow and ice control. Many agencies follow long time practices, especially in using only a salt/abrasive mix, that don't reflect the reality of how these materials work.

Mixing salt with abrasives

First, it is true that if you are going to use abrasives in winter, you need to add some salt. All sand piles have moisture, even those in desert environments. When this moisture freezes, lumps form and that interferes with distribution.

How much salt is needed? Just enough to keep the moisture from freezing. Practice has shown that 50-100 pounds of salt per cubic yard of abrasive is sufficient. This is about 2%-4% by weight. If your abrasive is very wet, you are in a very cold environment, or your stockpile is uncovered, you may find it necessary to use 175 pounds (7%). Also, if the abrasive is dirty, the larger volume of fines will tend to collect more moisture and therefore it takes more salt to prevent freezing.

Many states regulate salt and sand storage to protect surface and ground water. In Wisconsin, any entity storing more than 1000 pounds of bulk road salt must pile it on an impermeable pad and keep it securely covered year round. A sand mixture that is 5% salt by weight or less is exempt. Any mixture with more salt must comply.

Uncovered abrasives piles with salt are also susceptible to leaching with any significant amount of snow or rain during the winter. One study showed that 10 inches of precipitation leached out 50% of the salt. While it is difficult to keep salt/sand piles covered, doing so -- with a tarp or preferably a building -- would save salt and reduce leaching into the environment.

Many agencies have a tradition of mixing more than 5% salt in their abrasives. Blends of 10% to 50% can be found in use in nearly every state in the U.S. Why? The thinking goes: "if salt works well under some conditions and abrasives are helpful in others, why not mix them together for the best results?" In fact, salt and abrasives do different things and can actually oppose each other! The following sections explore some of the common explanations for these practices and their actual effectiveness in providing safety and producing bare pavements.

1. Anchor it to the road

A common belief is that salt will anchor the sand, and/or sand will anchor the salt to the road. Actually, sand and dry salt particles are separate and are not in any way tied or anchored together. As long as they remain dry, wind and traffic will quickly move both of them off the pavement.

Some salt may become brine from moisture in the sand or from melting ice on the pavement. In theory, a small amount of moisture will help embed the sand in the surface of the snow and then refreeze to create a sandpaper effect. This is a nice picture, and it can be done, but not very often.

Research on friction on pavements treated with abrasives shows that there is little benefit when traffic is present. In general, traffic quickly carries or blows all materials off the road. If there is

very much melting, it is not likely that the abrasive will float and stay on the surface. More likely it will settle, or be pounded by traffic, down into the melting snow mixture. Now it is no longer "anchored" to the surface and provides little value for traffic safety.

2. Sand will provide safety until the salt has a chance to work

People often use this approach when temperatures are too cold for salt to work. The object is to maintain traction until it warms up and the salt can go to work. This is true IF the sand stays in place and IF the salt also stays in place until it can to do its job of melting. The challenge is to keep the dry salt on the road. With any volume of traffic it will either be blown off the surface or mixed too far down into the snow to be effective.

If crews do any plowing before the temperature rises, this approach is a complete waste. The salt will be plowed off before it can possibly work. Any salt that remains may turn to brine and melt some of the ice on the road. This liquid on top of the ice actually makes the surface more slippery. Then, when the air temperature remains low it will likely refreeze the water, making the road surface ice covered. This leads to more salt applications and the process is repeated, wasting materials and not improving traffic safety very much.

3. We save salt by mixing it with abrasives

Bulk salt is more costly than bulk abrasives, so the idea is to "extend" the salt by mixing it with abrasives. However, if you are using a blend to achieve clear pavements, then salt and plowing are doing the work. Very likely most of the abrasive is wasted because blending salt and abrasives does not actually produce a different material. In fact, research has also shown that mixing sand with salt actually reduces the salt's melting ability. One study documents over 20% loss of ice melting capacity when salt is mixed with sand (2).

Spreading rates also differ between straight salt and an abrasives/salt mixture. Straight salt is usually spread at 100-300 pounds per lane mile. Spread rates for mixtures often run over 500 pounds per lane mile. If you are using a 3 to 1 blend by volume (sand to salt), the blend by weight is actually 20% salt (sand weight of 2700 lb/cu. yd. and salt weight of 2000 lb/cu. yd.). Spreading 500 pounds of this mixture per lane mile actually applies 100 pounds of salt per lane mile. A 50-50 blend by volume means that the salt is 43% by weight, giving a salt spread rate of 212 pounds. Because of the differences in spread rates, it may cost about the same or even more to spread an abrasive/salt mixture. Studies often show that abrasive/salt mixtures cost more than straight salt especially if any cleanup is required.

4. Sand is visible, and the public expects it

You bet! It is nice to spread something the public can see so they stop calling and complaining. You can add law enforcement to the group that likes to see sand on the road. Very likely our own operators and managers also feel the same way. Sand becomes a security blanket for everybody.

If the abrasive is really working, this approach is fine. However, there is a growing list of negative environmental concerns with abrasives. These include: air pollution from the fines, streambed pollution impacting fish reproduction, and corrosion from the salt included with the sand. In addition, problems with claims for windshield damage and chipped paint make the use of abrasives a source of public criticism.

Spreading abrasives mostly to be seen is very costly and not good for the environment. You are paying a high price to have sand just to look at. I doubt the public would be very supportive if they understood the situation.

5. We do not want the complication and expense of using more than one type of material

Yes, it takes more effort and training to use both straight salt and abrasives with 2%-4% salt. However, it will not cost more in the long run. In fact agencies are making this change all over the country at the state and local level. A realistic review of your total costs for spreading and cleaning up abrasives will likely show the benefits. Change is not easy, but many agencies feel it is worth the effort to make this improvement.

SUMMARY

In this day and age of new and exotic chemicals, anti-icing, RWIS and GPS, is there a place for good old sand? Yes. If however your agency is using a high percentage blend of salt with abrasives, you do have an opportunity to review your practice and seek improvements.

An abrasive mixed with enough salt to freeze-proof it, has a place on unpaved roads, low volume roads, and in conditions where chemicals can not work. Straight salt can both prevent ice from bonding to the pavement and create slush that allows plows to clear the road. This mix of strategies will serve most agencies well into the future. We owe the public nothing less.

References

1. **The Use Of Abrasives In Winter Maintenance Final Report Of Project TR 434,** Wilfred A. Nixon, IIHR Technical Report No. 416, Iowa Institute of Hydraulic Research, University of Iowa, March 2001.
2. **De-icing Chemicals and Abrasives: State of the Art,** J. Hode Keyser, Highway Research Record 425, p. 36-51 (1973).

Appendix B-3

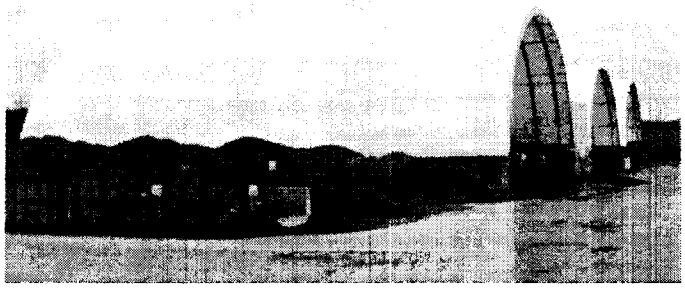
Subject: Fabric Roofed Salt Storage

From: Michael R. Hammond
Acting Venango County Maintenance Manager
Pennsylvania Department of Transportation
Maintenance District 1-5
1460 Pittsburgh Road
Franklin, PA 16323

When we needed to increase salt storage at our main stockpile, the cost for the traditional wooden building was high enough to look for alternative storage options. Terry Rush, Regional Facility Administrator for PENNDOT in Western Pennsylvania, suggested fabric roofed storage as a possible solution.

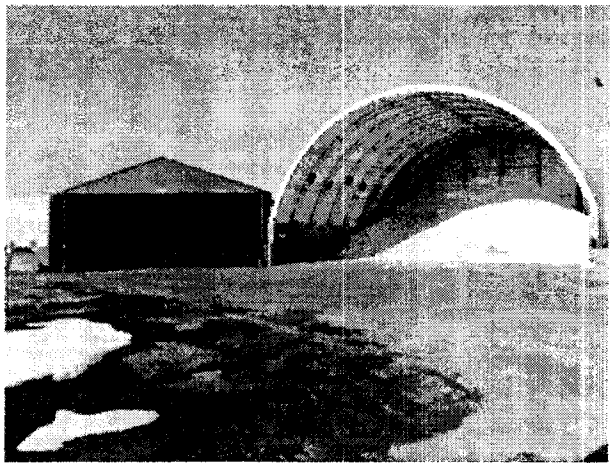
He noted that the cost for a wooden Hi-Arch Gambrel building large enough to hold 2000 tons was approximately $190,000 to $225,000. The cost for a fabric-roofed building with wooden sides to hold the same amount of salt was approximately $80,000 to $95,000. The durability of both buildings is about the same. The repair cost for a new shingle roof is around $40,000 to $60,000 and the cost for a new tarp is in the neighborhood of $2,500 to $4,000. You can e-mail Terry Rush at trush@state.pa.us

We purchased a fabric-roofed building with wooden sidewalls that year. Since then we have added two more to the site, as pictured. All three buildings have wooden sides backed up with fill. Our crews put in asphalt floors.

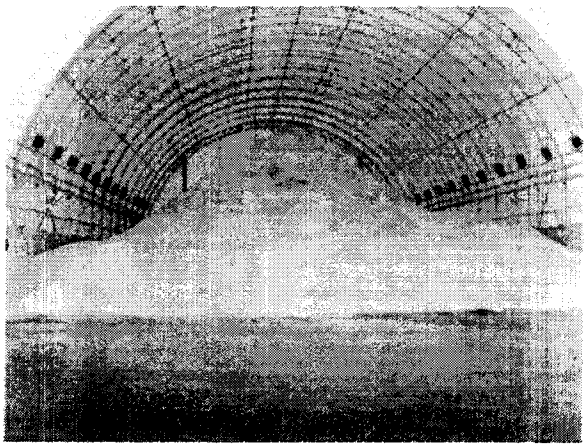


There are many things to consider before purchasing a fabric storage building. While wooden sidewalls are the most economical, concrete may better suit your needs.

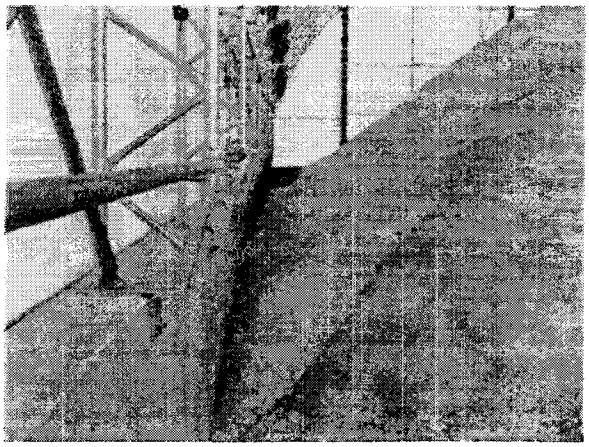
Pictured is our Mapleshade stockpile building with poured concrete walls. Make sure the building you choose will withstand wind and snow loads



for your area. This building is located in our Clintonville stockpile. It has ten-foot high concrete walls. At seventy feet wide and one hundred four feet long, it can be difficult to estimate salt inventory.



Tim Wagner, Roadway Programs Coordinator, and Brad Alden, Roadway Programs Technician 2, developed the signing system shown. Barely visible are vertical boards to help estimate the height of material left and right. With some quick readings and the help of a spreadsheet, Tim can accurately estimate material inventories.



Durability and strength of the framework depends on the materials and manufacturing process as well as the type of galvanizing used to protect the steel from corrosion.

Fabrics vary as well. Choose a fabric That will withstand the extremes in your region. Check to see if there is a warranty on the fabric. Repair kits are available from some manufacturers for minor cuts or tears. Eliminate fabric wear points in your design of the sidewalls and consider the overhead clearance for haul trucks.

Fabric buildings are definitely worth consideration as an economical storage option.

Appendix C-1

Essential Topics for Comprehensive Winter Maintenance Training

	Key Audience*		
	Oper	Sup	Mgr
1. Importance of Winter Operations	x	x	x
a. Safety			
b. Mobility			
c. Liability			
2. Policy and Planning			
a. Creating a Local Plan & Policy			x
b. Level of Service	x	x	x
c. Working with Elected Boards and other Agencies			x
d. Legal Issues		x	x
e. Personnel Policy		x	x
f. Public/Media Relations	x	x	x
g. Safety Program	x	x	x
h. Contract Services		x	x
i. Continuous Improvement	x	x	x
j. Road Design for Winter Maintenance			x
3. Environmental Issues			
a. Impacts of Materials	x	x	x
i. Humans			
ii. Air			
iii. Water & Soil			
iv. Animals and Plants			
v. Structures			
vi. Vehicles			
b. Sensitive Areas	x	x	x
c. Storage & Handling of Materials	x	x	x
d. Snow Disposal		x	x
e. Equipment Cleaning	x	x	
4. Snow and Ice Control Materials	x	x	x
a. Chemicals			
i. Types – Chlorides, organics, other non-chlorides			
ii. Solids/Liquids			
iii. Chemical Terminology			
iv. How Chemicals work			
v. Combinations of Chemicals			
b. Abrasives			
c. Storage and Handling			

5. Snow and Ice Control Equipment			
a. Trucks and Plows	x	x	x
b. Special Purpose Equipment	x	x	x
c. Outsourced Equipment		x	x
d. Materials Spreading Equipment	x	x	x
i. Calibration			
ii. Ground Speed Controls			
iii. Spread Pattern Control			
iv. Discharge vs Application			
e. Equipment and Staffing		x	x
6. Snow And Ice Control Strategies	x	x	x
a. Winter Storms – types, conditions			
b. Paved vs Unpaved Roads			
c. Plowing			
d. Deicing			
e. Prewetting			
f. Anti-icing			
g. Use of Abrasives			
h. Pickup and Disposal			
i. Traffic Control, Road Closure			
j. Passive Snow Control – snow fence, drift control			
k. Doing Nothing			
7. Preparation			
a. Update policies		x	x
b. Update routes	x	x	
c. Order materials		x	x
d. Training operations personnel		x	x
e. Ready Equipment	x	x	
i. Calibration			
f. Running Routes	x	x	
g. Trimming trees, roadside preparation, etc	x	x	
h. Update contact list		x	x
i. Snow Fence, delineators, signs, etc.	x	x	
8. Operations			
a. Designing S&I Control Material Treatment	x	x	x
i. Precipitation Definitions			
ii. Pavement Condition Definitions			
iii. Operational Procedure Terms			
iv. Regional and Local Weather and Climate			
v. Factors influencing Chemical effectiveness			
vi. Chemical Dilution			
vii. Deciding on a Snow and Ice Control Treatment			

b. Material application			
i. Type, amount, timing	x	x	x
ii. Procedures	x	x	
1. 2-lane 2-way Roads			
2. Multilane Highways			
3. Unpaved Roads			
4. Parking Areas and Walkways			
5. Hills, Curves & Intersections			
6. Bridges			
7. Railroad Crossings			
8. Banked or Elevated Curves			
iii. Changes in Jurisdiction (or Level of Service)	x	x	x
iv. Worst-case Scenarios	x	x	x
v. Getting the Application Right	x	x	
c. Plowing			
i. Procedures	x	x	
1. 2-lane 2-way Roads			
2. Multilane Highways			
3. Unpaved Roads			
4. Parking Areas and Walkways			
5. Hills, Curves & Intersections			
6. Bridges			
7. Railroad Crossings			
8. Banked or Elevated Curves			
ii. Obstructions	x	x	
iii. Safety Restoration and Cleanup	x	x	
d. Removal			
i. Emergency Snow Routes		x	x
ii. Disposal Areas – maintenance, drainage	x	x	x
e. Safety/Roadside Hardware Restoration	x	x	
f. Storm Debriefing	x	x	x
g. Recordkeeping & Analysis	x	x	x
8. Technologies			
Implementing improvements	x	x	x
Evaluation/Assessment		x	x

*Key Audience:

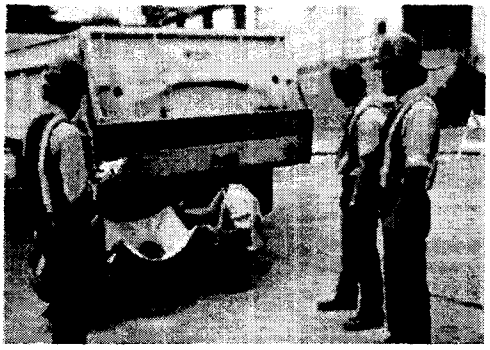
Oper: Operators, Crew Members
Sup: First Line Supervisors, Crew Leaders
Mgr: Public Works Directors, Road Superintendents, Other Management

Appendix C-2

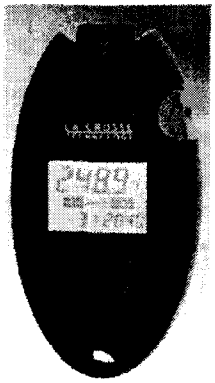
Important Winter Maintenance Technologies

Items that can be implemented with little cost in time or dollars:

1. Appropriate Operational Strategies
2. Calibration (photo a)
3. Portable infrared thermometers for pavement temperature (photo b)
4. Utilization of weather forecasting and/or RWIS (e.g. via DOTs)
5. Air Puffers - pneumatic removal of snow from rear lights



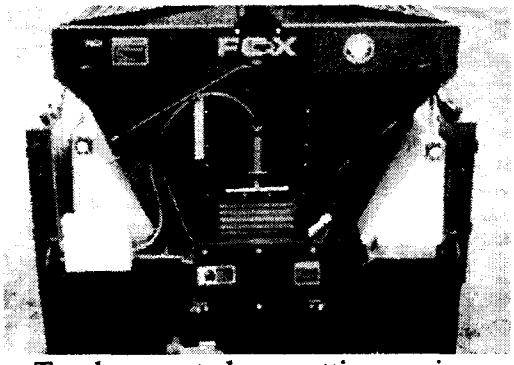
a. Calibration of a tailgate salt spreader



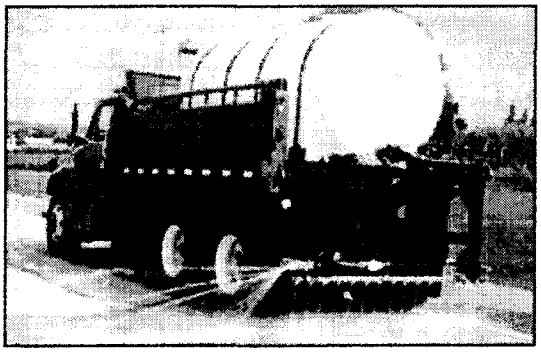
b. Portable infrared thermometer

Items that can be implemented with modest investment:

6. Ground Speed controls
7. Prewetting (photo c)
8. Anti-icing (pavement treatment with liquid chemicals) (photo d)



c. Truck-mounted prewetting equipment



d. Anti-icing spray equipment

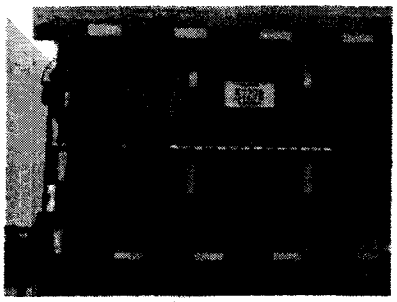
9. Plow blades – different materials
10. Truck-mounted Infrared thermometers for pavement temperature
11. High Intensity Discharge Lighting (photo e)
12. Insta-Chains (photo f)
13. Slush blade
14. Wing Plows (photo g)

e. High Intensity Discharge Lighting

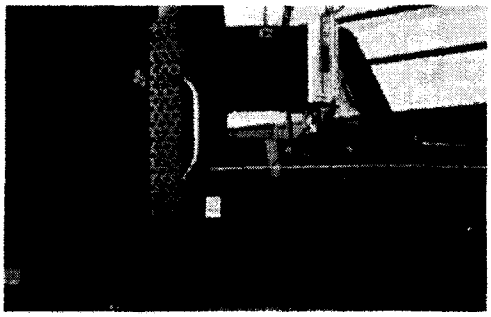
f. Insta-Chains

g. Wing Plow

15. Truck Safety Items
    - Heated windshield
    - Heated mirrors
    - Heated wipers
    - Lighting packages – warning light package (photo h)
    - Side door windows – wing plow visibility (photo i)
16. Air Foil for rear of truck (high speed plowing) (photo j)
17. Snow Plow Deflector Shield (photo k)

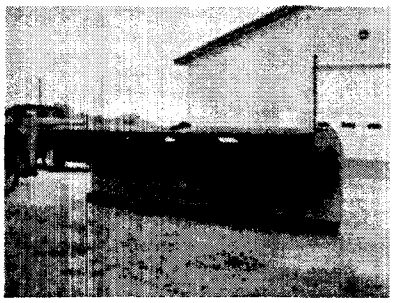


h. LED lights on tailgate



i. Side door window

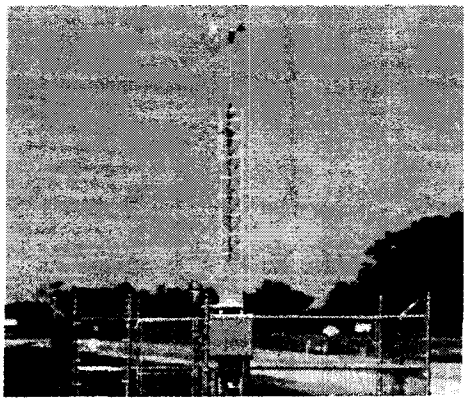
j. Air foil – blowing air keeps lights clean



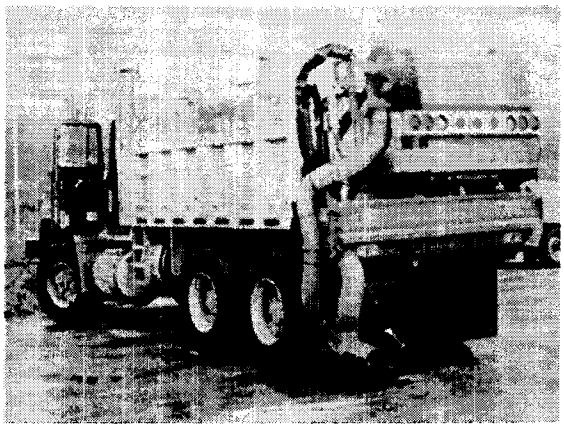
k. Snow plow Deflector shield

Items that can be implemented with greater investment:

18. GPS
19. Magnetic Centerline Pavement Markings
20. Automated Bridge Anti-icing (FAST)
21. RWIS - Road Weather Information Systems (photo m)
    - Pavement Temp
    - Pavement Temp Forecast
    - Chemical Concentration
    - Atmospheric Sensors
22. MDSS Maintenance Decision Support System
23. Zero Velocity Spreaders (photo n)

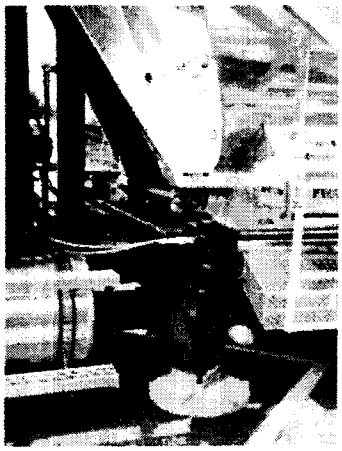


m. RWIS



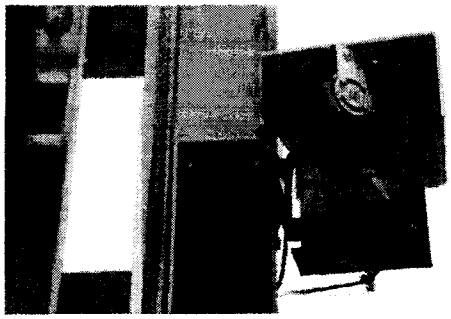
n. Zero Velocity Spreader

24. Front dump discharge spreaders (photo o)
25. Side discharge spreaders (photo p)
26. Rear-mounted video (photo q)
27. Underbody plows (photo r)

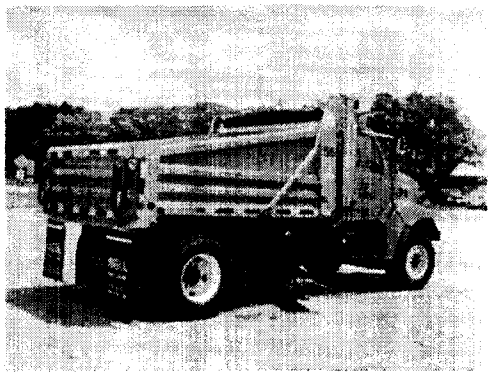


o. Front dump with belt & spinner (left or right side)

p. Side discharge with auger



q. Rear view video camera



r. Underbody plow

Appendix C-3

Salt Brine and New Chemical Research

By David H. Fluharty, Director
New Hampshire T2 Center

Winter operations chemical suppliers rarely substantiate their claims with results from rigorous research. Some state and local agencies test new chemicals, but too often their research has methodological flaws.

The most common methodology problem is that researchers concurrently change chemicals and application techniques. Technique changes are usually from post to pretreatment, or anti-icing. By changing chemicals and techniques at the same time, researchers, and managers evaluating the research, cannot determine which change is responsible for the results. In addition, many researchers compare data for the new chemical applied in one year and compare chemical usage in prior years.

Similarly, states and large cities are increasingly using liquid NaCl instead of solid. Many are finding the limits of liquid NaCl applied to cold pavements, or after air temperatures drop. They have found that they must still apply solid NaCl before and during certain storms. Most important, there is no known research on the relative benefits of liquid and solid NaCl when agencies apply both with anti-icing techniques during the same storms.

In addition, agencies frequently modernize equipment for a new chemical or liquid NaCl. Such changes usually include ground speed control and improved control of application rates. Finally, changing chemicals tends to increase attention on chemical use and its management. Thus, the change process itself can influence test results. Researchers rarely define these factors as variables in their methodologies.

Changing chemicals, techniques, application rates, and equipment, and increased management attention, can each reduce chemical usage and costs. Rigorous research is needed to isolate the affect of liquid NaCl or a new chemical from these other factors. In addition, it should determine the extent of resulting levels of service and costs.

The following research design accomplishes these goals. For many, the testing process will seem expensive. It can be more expensive to accept invalid conclusions. Moreover, applying invalid research results can reduce winter operations effectiveness, and even motorist safety.

Salt Brine Research Design

The research purpose is to compare the effectiveness and efficiency of liquid NaCl applications compared to prewet, solid NaCl applications during the same storm and over similar roads. With minor modifications, agencies can use the design to compare other chemicals to liquid or solid NaCl.

The design assumes that the agency applies the best practices for both liquid and solid NaCl applications. These practices include calibrated spreaders and prewetting the solid chemical with liquid $CaCl_2$ or $MgCl_2$ when pavement temperatures indicate their use in *Anti-icing of Local Roads: A Manual of Practice.* (http://www.t2.unh.edu/pubs/anti-icingman.pdf; see also NCHRP Report 526 at http://gulliver.trb.org/publications/nchrp/nchrp_rpt_526.pdf)

Dependent Variable Measurement.

There are two dependent variables: effectiveness and cost. Effectiveness is measured by the scale described in Attachment 1, "Snow-Ice Treatment Effectiveness."

- A treatment is "effective" if the road is in Conditions 1 through 3
- A treatment is "ineffective" if the road is in Condition 4 or worse.

Cost is the total of equipment, materials, and labor used for each chemical type during each storm. Researchers should calculate hourly equipment rates for all equipment: handling and mixing equipment as well as trucks and chemical spreaders. Labor should also include handling and mixing labor as well as spreader operators. Labor rates should include fringe benefits.

Research Questions.

1. At what pavement temperatures are liquid NaCl applications effective ?
2. Below what pavement temperature does a liquid NaCl application become ineffective?
3. Below what air temperature does a liquid NaCl application become ineffective?
4. At what pavement temperatures are prewet, solid NaCl applications effective?
5. Below what pavement temperature does a prewet, solid NaCl application become ineffective?
6. Below what air temperature does a prewet, solid NaCl application become ineffective?
7. What is the cost of applying liquid NaCl to achieve effectiveness?
8. What is the cost of applying prewet, solid NaCl to achieve effectiveness?

Research Design.

The agency should select roads, sequence applications, and record data in the following steps.

Table 1. Application Sequence

Road Type	State of NaCl Applied	
	Odd Numbered Storms	**Even Numbered Storms**
Rural		
A	Prewet, Solid	Liquid
B	Liquid	Prewet, Solid
Residential		
A	Prewet, Solid	Liquid
B	Liquid	Prewet, Solid
Urban		
A	Prewet, Solid	Liquid
B	Liquid	Prewet, Solid

1. Select road sections, in pairs for each "Road Type," with the same:
   - Geometry
     - ⇒ Width
     - ⇒ Surface condition
     - ⇒ Curbs/shoulders
     - ⇒ Elevation
     - ⇒ Driveways
   - Traffic volume and weight
   - Route length
   - Wind and sun influence
     - ⇒ Prevailing wind
     - ⇒ Trees
     - ⇒ Buildings
     - ⇒ North-south, east-west, orientation
   - Equipment
     - ⇒ Calibrated
     - ⇒ Ground speed control

2. For each Road Type, apply prewet, solid NaCl on one set of road sections, and liquid NaCl on the other, following anti-icing procedures for both applications. See Table 1 below.
3. Before and during alternate storms, reverse the applications. (See "example" under **Data Collection**.)
4. Record for each application data for each of these independent variables:
   - Pavement temperature
   - Type precipitation
   - Application rates (lbs/LM)
   - Quantities used
   - Effectiveness Condition (Attachment 1)
   - Hours spreading chemical
   - Hours plowing
   - Mixing and handling times
5. If preliminary analysis shows unusual differences, change operators and repeat.

Data Collection.

Agencies should record data during a storm as shown in the following example. An "X" indicates the necessary data. Agencies should also collect other information to determine costs.

Date Time	Road Type	NaCl State	Air Temp	Pave Temp	Type Precip	Applic Rate	Effect. Cond.	Hrs to Apply	Comments
122004 0830	Rural A	Prewet, Solid	X	X	X	X	X	X	X
122004 0830	Rural B	Liquid	X	X	X	X	X	X	X
122004 1130	Rural A	Plowing Only			X		X	X	X
122004 1130	Rural B	Plowing Only			X		X	X	X
122004 1500	Rural A	Prewet, Solid	X	X	X	X	X	X	X
122004 1500	Rural B	Liquid	X	X	X	X	X	X	X

Analysis.

Analysts can apply several statistical techniques to determine answers to the research questions. When they consider variable levels of measurement, they should note that "Effectiveness Condition" is ordinal level.

Additional analysis can also help the agency become more effective and efficient when applying these techniques. Analysts should consider effectiveness and costs results at various times during a winter season.

Attachment 1

Snow-Ice Treatment Effectiveness

The key anti-icing effectiveness measure is whether snow or ice has bonded to the pavement. The following effectiveness measures emphasize bonding, and have additional criteria. They are adapted from "Table 1 -- Descriptions of pavement snow and ice conditions" on Page 4 of NCHRP Report 526, *Snow and Ice Control: Guidelines for Materials and Methods*.

Condition 1: All snow and ice are prevented from bonding and accumulating on the road surface. Bare/wet pavement surface is maintained at all times. No weather-related traffic delays other than those associated with wet pavement surfaces, reduced visibility, incidents, and "normal" congestion.

Condition 2: Bare/wet pavement surface is the general condition. Occasional areas have snow or ice accumulations resulting from drifting, sheltering, cold spots, frozen melt-water, etc. Prudent speed reduction and general minor delays are associated with traversing those areas.

Condition 3: Accumulations of loose snow or slush are on the pavement surface. Packed and bonded snow and ice are not present. There are some moderate delays due to a general speed reduction. However, the roads are passable at all times.

Condition 4: The pavement surface has continuous stretches of packed, bonded snow with or without loose snow on top of the packed snow or ice. Wheel tracks may range from bare/wet to slush or unpacked, unbonded snow. On multilane highways, only one lane will exhibit these pavement surface conditions. There is a reduction in traveling speed and moderate delays due to reduced capacity. However, the roads are passable.

Condition 5: The pavement surface is completely covered with packed, bonded snow and/or ice. There may be loose snow on top of the packed surface. Traveling speed is significantly reduced and there are general moderate delays with some incidental severe delays.

Condition 6: The pavement surface is covered with a significant buildup of packed, bonded snow and/or ice. There may be loose or wind-transported snow on top of the packed surface due to high snowfall rate and/or wind. There may be deep ruts in the packed snow and ice that may have been treated with chemicals, abrasives, or abrasives/chemical mixtures. Travelers experience severe delays and low travel speeds due to reduced visibility, unplowed loose, or wind-compacted snow, or ruts in the packed snow and ice.

Condition 7: The road is temporarily closed. This may be the result of severe weather (low visibility, etc.) or road conditions (drifting, excessive unplowed snow, avalanche potential or actuality, glare ice, accidents, vehicles stuck on the road, etc.).

Condition	Bonded Snow/Ice	Accumulation	Traffic Delays
1	No bonded snow or ice	None	None except those associated with wet pavement surfaces, reduced visibility, incidents, and "normal" congestion
2	No bonded snow or ice	Occasional areas having snow or ice accumulations resulting from drifting, sheltering, cold spots, frozen melt-water, etc	Prudent speed reduction and general minor delays associated with areas of accumulation
3	No bonded snow or ice	Loose snow or slush on the surface	Moderate delays due to a general speed reduction; roads are passable at all times
4	Partial; no bonding in wheel paths	Stretches of bonded snow pack. Wheel tracks range from bare/wet to slush or unpacked, unbonded snow	Roads are passable but traveling speeds reduced and moderate delays due to reduced capacity
5	Yes, surface completely covered with bonded snow or ice	May be loose snow on top of the packed surface	Traveling speeds significantly reduced and general moderate delays with some incidental severe delays.
6	Yes, surface completely covered with bonded snow or ice; significant build up	May be loose or wind-transported snow on top of the packed surface and/or deep ruts in packed snow and ice	Severe delays and low travel speeds due to reduced visibility, unplowed loose, or wind-compacted snow, or ruts in the packed snow and ice
7	Yes, surface completely covered with bonded snow or ice; significant build up	Severe weather, drifting, excessive unplowed snow	Road temporarily closed

Appendix C-4

National Cooperative Highway Research Program - Active Project 6-16

Guidelines for the Selection of Snow and Ice Control Materials To Mitigate Environmental Impacts

Res. Agency:	Levelton Consultants, Ltd.
Principal Invest:	Brent T. Mussato
Effective Date:	June 2, 2003
Completion Date:	June 1, 2005
Funds:	$249,968
NCHRP Staff:	Christopher Hedges

BACKGROUND

Every year, considerable quantities of snow and ice control products are applied to highways, and environmental and regulatory agencies have questioned the environmental impact of these products. Transportation agencies are asked to use "environmentally friendly" or less toxic alternatives wherever possible, but there is no commonly accepted guidance for determining which products meet these criteria. The traditional use of road salt has been prohibited in some locations, leaving highway agencies uncertain about how traffic safety can be maintained in bad weather. For example, Environment Canada has concluded that inorganic chloride road salts are harmful to the environment under the Canadian Environmental Protection Act, thus requiring development and implementation of improved management practices.

Studies of the most common chemical alternatives--sodium chloride (salt), magnesium chloride, calcium chloride, calcium magnesium acetate, potassium acetate, and urea--have focused on performance and cost under various weather conditions without evaluating their relative impacts on the environment. Several new chemical preparations, including some that are trademarked, have entered the market as snow and ice control chemicals for use by transportation agencies, but there is limited information about their environmental impacts.

There is a need for rational decision-making guidelines to assist DOT maintenance managers in selecting the most appropriate snow and ice control materials for the conditions that exist in their jurisdictions.

OBJECTIVE

The objective of this project is to develop guidelines for selection of snow and ice control

chemicals and abrasives, based on their constituents, performance, environmental impacts, cost, and site-specific conditions.

For the purpose of this study, environmental impacts include effects on human health; aquatic life; flora and fauna; surface-water and groundwater quality; air quality; vehicles; and physical infrastructure including bridges, pavements, railway electronic signaling systems, and power distribution lines.

Accomplishment of the project objective will require at least the following tasks.

TASKS (*1.*) Compile, analyze, critique, and document relevant domestic and international information, on the basis of applicability and usefulness to achieving the project objective. The review should include published information, current practices, and research in progress, and cover the following topic areas:

- Range of materials available for snow and ice control;
- Typical costs of materials;
- Ease of use and any health concerns associated with handling, storage, and application;
- Environmental impacts, primarily those related to common usage and application, but with consideration of impacts related to storage and disposal;
- Site-specific conditions that impact choice of material/locations where specific materials are prohibited or inadvisable;
- Current and proposed specifications used for acceptance and how they vary by jurisdiction (state and provincial agencies) or region; and
- The full range of parameters and test methods used to evaluate the performance and environmental impacts of the materials.

(*2.*) Summarize, categorize, and quantify the most significant factors that should be considered in the selection of materials. Identify trends that will affect the selection of snow and ice control materials in the near- to mid-term future.
(*3.*) Develop a draft framework for the proposed material selection guidelines. The draft framework should be presented in sufficient detail so as to illustrate the initial thinking of the contractors on how DOT maintenance managers will select snow and ice control materials, taking into account factors such as material properties and constituents, site-specific conditions (e.g., climate and proximity to wetlands or other sensitive areas), the regulatory environment, and storage and application procedures. The framework should specify the intended format for the guidelines, (e.g. decision tree or flowchart, spreadsheet application, or computer model). (*4.*) Identify and justify which test methods are most effective for measuring the properties and constituents that determine the environmental impacts of the current range of snow and ice control materials. These should include, but not be limited to, properties such as BOD, COD, pH level, toxicity, and corrosivity, and constituents such as heavy metals, nutrients, and additives. (*5.*) Identify gaps and needs from Tasks 1 through 4. Recommend areas where additional laboratory testing is required in this project to determine or verify the constituents and

environmental impacts of current materials using the methods identified in Task 4 above. The contractor should ensure that the proposed tests are designed to produce statistically valid results. (*6.*) Submit an Interim Report that documents the results of Tasks 1 through 5 and includes a revised work plan for accomplishing the remaining tasks. The contractor will be expected to meet with the NCHRP approximately 1 month later. The research agency shall not begin work on the remaining tasks without NCHRP approval. (*7.*) Upon approval of the Interim Report by the NCHRP, conduct the laboratory testing identified in Task 5 and approved by the project panel. (*8.*) Produce a matrix describing currently available materials and their significant properties identified in Task 4 above. (*9.*) Develop a purchase specification and quality assurance test protocol for the evaluation of existing and future materials. (*10.*) Following the plan approved during review of the Interim Report, develop guidelines that incorporate (1) a decision-making process for the selection of snow and ice control chemicals and abrasives, based on their composition, performance, environmental impacts, cost and site-specific conditions; (2) the matrix of currently available products and their properties; (3) the purchase specification, and (4) the quality assurance test protocol. (*11.*) Submit the draft Task 10 guidelines to the NCHRP and to a sample of winter maintenance professionals for review. The reviewers should include a selection of DOT maintenance managers from U.S. states and Canadian provinces. The reviewers selected should include members of the Pacific Northwest Snowfighters Association and of AASHTO's Winter Maintenance Policy Coordinating Committee. (*12.*) Compile and submit the comments received from the reviewers, and submit a technical memorandum to the NCHRP indicating how the review comments will be addressed. (*13.*) Submit a final report that documents the entire research effort and includes the revised Task 10 guidelines as a stand-alone product. In addition, provide a companion executive summary that outlines the research results. Provide recommendations for research needed to further develop, refine, or implement the decision-making guidelines.

Status: The interim report has been received and has been approved by the project panel.

Appendix C-5

National Cooperative Highway Research Program - Completed Project 6-13

Guidelines for Snow and Ice Control Materials and Methods

Res. Agency: Midwest Research Institute
Principal Invest: Robert R. Blackburn
Effective Date: March 2, 1998
Completion Date: May 26, 2003
Funds: $748,252

The project produced guidelines for selecting roadway snow and ice control strategies and tactics for a wide range of winter maintenance operating conditions. These guidelines apply to highways, roads, streets, and other paved surfaces that carry motor vehicles--under state or local jurisdictions and provide a basis for selecting the appropriate level-of-service (LOS)-driven roadway snow and ice control operations.

Snow and ice control on the U.S. highway system consumes billion of dollars--in direct costs and costs associated with corrosion and environmental impacts--each year. Strategies and tactics that employ solid and liquid chemicals, abrasives, and mechanical methods--individually or in combination--have been used by state and local agencies. In spite of many studies of issues associated with snow and ice control treatments, widely accepted guidelines for selecting roadway snow and ice control strategies and tactics for specific climatic, site, and traffic conditions have not emerged. Therefore, there is a need to develop guidelines that delineate a process of selecting treatment strategies and tactics that meet highway agency objectives.

The research (a) identified the climatic, site, and traffic conditions that affect the selection of snow and ice control strategies and tactics to achieve agency objectives (e.g., LOS), and listed in a rank-order the criteria necessary to assess the performance of treatments; (b) identified the snow and ice control strategies and tactics in current use that may be applicable to U.S. conditions and highlighted for each strategy and tactic the conditions of use, selection criteria, evaluation methods, effectiveness, and related problems; (c) identified specific snow and ice control strategies and tactics that merited further evaluation and developed a plan for their field evaluation in different environments under different site and traffic conditions; (d) conducted investigations of several potential snow and ice strategy and tactic combinations during three winter seasons and collected information necessary to relate the effectiveness of each of these combinations to the climatic, site, and traffic conditions; and (e) developed guidelines that can be used for selecting appropriate snow and ice control strategies and tactics for specific climatic, site, and traffic conditions to achieve agency objectives. The findings of this research pointed out the importance of (1) ensuring that snow and ice control strategy/tactic combinations are LOS driven; (2) using nowcasting results, materials characteristics, traffic volume, and cycle time considerations in the treatment decision

making; and (3) providing flexible winter maintenance operations to deal with the variety of precipitation types, especially those occurring within a given weather event. NCHRP Report 526 "Snow and Ice Control: Guidelines for Materials and Methods" contains the guidelines developed in the project.

Standard
Guide for Snow and Ice Control
Document Number: AASHTO GSIC
American Association of State and Highway Transportation Officials
01-Jan-1999

Order Printed Edition
(English)
$68.00 USD
(Usually Ships From Techstreet In 3 - 5 Days)
Description: This guide presents a comprehensive overview of the components required for a successful snow and ice control program. It describes the purpose for snow and ice control and how to achieve an appropriate level of service. The guide discusses the importance of involving other jurisdictions, the media, emergency management services, and the public in developing policies and practices to provide the level of service.

Appendix D-1

Participants' Personal Comments on their Exchange Experience.

From Dick Hanneman:

Perspective on the Exchange
What an enlightened idea. This group of experienced and committed experts who provide snowfighting training was task-oriented and productive. Exchanging "war stories" about what works and what doesn't, why clients seek training and why they don't, and what elements represent the core of a snow and ice curriculum was an education all in itself. It confirmed that while much training is done, most snowfighter operators and supervisors are not trained every year, some not even every several years and some not at all. Identifying the barriers to reaching these underserved target groups should help each LTAP center reach out to its clientele, taking a more proactive role in educating transportation agencies to the value of winter maintenance training, even in states not normally considered "Snowbelt."

Lessons learned
I think we learned that this idea works pretty much as designed. The key will be how to transfer this information to those LTAP Centers and trainers not participating. It is infeasible to spend the entire NLTAPA meeting on this single subject, nor do all winter maintenance trainers attend. One idea adopted at the peer exchange is that the University of New Hampshire (NHLTAP) agreed to establish a listserv especially for snowfighting training. Participants indicated their willingness to contribute posts to get the listserv properly launched.

Recommendations for future exchanges
Keep the same design, same length, same size. I'd suggest bringing in a couple younger and less-experienced trainers, perhaps some from Sunbelt areas as well. Canada faces the same training challenges and has significant, relevant experience that could also be tapped by including one or two Canadian trainers. The main thing is to make sure that the results are communicated and, if possible, a "community" of trainers continues to feed itself. Hopefully, the listserv will move us strongly forward in this area. An evaluation of the effectiveness of the peer exchange would help: perhaps a survey a year from now as to what changes were actually made, etc.

From Russ Neyman:

Perspective on the Exchange: This was a fantastic format to meet others who share the same interests and concerns about winter maintenance training. I learned a great deal

from everyone at the exchange and gained new perspectives in how each of us attacks the issues for their respective regions.

Lessons Learned: As expected a great deal of information was shared during the exchange. The common bond shared by the group resulted in great creative energy that should be captured frequently and not wait for the next peer exchange. We do not share enough information although everyone is willing to do so but time, and an appropriate forum is necessary. Perhaps having a standing meeting of this type group during the APWA Snow Conference would assist information sharing.

Recommendations for Future Exchanges: To continue to build on what was developed during this exchange, I believe that a follow-up meeting should occur within the next year. Exchanges could then occur every 2-3 years to keep the information current and perhaps alter the attendee mix to have fresh viewpoints. This exchange and the information derived from it is critical to our continued improvement of snow operations and how we can train the people to be safer, and better stewards of the assets provided to them.

From Dennis Burkheimer:

Overview: I felt the exchange offered me a rare opportunity to meet with LTAP representatives that were actively involved in winter operations training and the development of training packages for public agencies. It was obvious that those in attendance were very interested in providing quality winter maintenance training packages to end users and looking for ways to help improve training at a national level.

Lessons learned:

- LTAP is actively involved in development of training for public agencies
- With budget constraints at all levels there is a greater need than ever before for public agencies to consolidate or share training
- There are more training resources available through the Salt Institute and LTAP centers than I anticipated
- DOTs need reach-out to cities and counties to let them know what resources they have available to use to support snow and ice removal operations

Future exchanges: I think there is a need for more exchanges but would like to see participation from other parts of the country.

From Mike Hammond:

I was pleased to be asked to participate in the exchange. I did not know what to expect and thought the agenda had a wide scope. When I looked at the credentials of the other attendees, I was worried about being able to make a positive contribution.

When we actually got underway, I found a great group of knowledgeable people had been assembled. It was pleasure to get to know each of them and hear first-hand their individual perspectives on the topics discussed. I learned from them that although there are some variations in the methods and ideologies used to manage winter services, everyone was striving toward the same basic goal. That objective is being more efficient in our management of winter services through identifying best practices and training everyone to utilize them.

Future exchanges might concentrate on one or two specific topics that would be beneficial to everyone. I was amazed at the resources available from others at the exchange. I would pick the use of liquid chemicals or perhaps new spreader technology as subjects to be discussed.

From Mike Blankenship:

This was an excellent opportunity to learn about winter maintenance training tools, techniques, and practices from around the country! Some things I learned that will be helpful to our future training and technical assistance efforts: great websites with great info (Transportation Association of Canada, Iowa DOT, etc.), AASHTO Anti-Icing/RWIS interactive training CD, weekly fact sheets that the Iowa DOT sends to its personnel, Winter Storm Case Studies from Wisconsin LTAP, training materials from New York LTAP and Paul Brown, and information on new technologies.

This is the second training peer exchange I've participated in (Maintenance Peer Exchange in PA was the other one), and I highly recommend them. I think FHWA should fund at least one peer exchange a year for trainers. Ideas for future peer exchanges: Drainage, Work Zone Traffic Control, and Worker Safety.

From Mark Sandifer:

Personal perspective regarding the exchange.
It was quite a feet to gather such knowledgeable experts in the same room at the same time for more than one day. It seemed like each person had their own areas of expertise and by putting all of us together we were able to share and exchange great ideas. I took away from this peer exchange more knowledge and information on icing and deicing materials and how used properly can be one of the best tools for fighting snow and ice. I feel a peer exchange like this might have a paper written and submitted to TRB. A peer exchange is needed like this every two years or after two winters to retake the pulse of the nation's winters.

From Alan L. Gesford:

Personal Perspective. Having been given the responsibility to coordinate this exchange effort, I am delighted at the resulting success. Although the coordination task was significant in time and effort, it was well worth that time and effort. To gather the group of winter maintenance experts and then be part of that group, sharing in the discussions and results was a fulfilling experience. I found the exchange invaluable in networking with my peers. We had a very intense session and could have spent many more hours on many topics and with, I believe, additional significant results. This only reinforces the recommendation that more communication /networking and sharing of information by all those involved in winter maintenance operations is needed, and could only result in benefits toward a more effective, efficient and safe national transportation system.

I would like to thank my fellow participants and their respective organizations and the project sponsors for providing me with this learning experience.