Metro Division Snow and Ice Research Field Studies 1992-1993 Winter Season
METRO DIVISION
SNOW AND ICE RESEARCH FIELD STUDIES
1992-1993 WINTER SEASON

FINAL REPORT

Prepared by
Michael Barnes

Minnesota Department of Transportation
Metro Maintenance Operations
Water’s Edge Building
1500 W. Co. Rd. B-2
Roseville, MN 55113-3105

May 1993

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ACKNOWLEDGEMENTS

To complete these three field studies it took the cooperation of many people. I would like to thank the following:

- Everyone in the Camden, Lakeville, and Plymouth shops, especially all those directly involved in the testing.
- The Metro Maintenance Operation staff and the Administrative Support Unit for the strong support.
- The field observers and their supervisors from the Northwest and Mendota Construction Offices, and Metro Bridge Unit.
- Everyone involved from the Highway Equipment unit, especially the mechanics that kept everything going.
- Mn/DOT Maintenance personnel from other areas, especially those doing similar research; St. Cloud, Glencoe, Willmar, Bemidji, Owatonna, Rochester, Duluth, and Mankato sub-areas.
- Everyone involved from the Mn/DOT Central Shop in giving technical support on equipment issues.
- Central Office Maintenance for guidance and strong support.
- The Golden Valley Radio shop for the technical support for solving the controller problems.
- The Field and Auto supply units for keeping the needed logistics flowing.
- Representatives from the Swenson, DICKEY-john, Cargill, and Reed Systems companies for their technical support.
- Ken Nelson, the senior highway maintenance worker that assisted me in coordinating all the projects and preparing portions of this report.
- Also, to everyone else that helped in anyway to help make the field tests a success. We need to continually find ways to improve the way we do business and it takes the commitment and support of everyone to make it happen.
EXECUTIVE SUMMARY

A. KEY TERMS

As stated in the Mn/DOT Ice and Snow Removal Training Manual: "Ice forms a very tight bond to the porous surfaces of highway pavements. Since water expands when it freezes, water filled pores become tightly wedged pockets of ice that serve as anchors to any additional ice that forms above them."

1. De-icing refers to the process of breaking the ice bond after it forms.
2. Anti-icing refers to the process of preventing this bond from happening by applying chemicals prior to the snow and ice.
3. Pre-wetting is the process of putting a liquid chemical onto dry material for either de-icing or anti-icing.

B. PRE-WETTING BACKGROUND

Several other states (New York, Ohio, Washington, Colorado) and countries (Sweden, Finland, Norway, Switzerland) have tried or are currently using pre-wetting as part of their normal snow and ice operations for de-icing or anti-icing. There are a number of different liquid solutions, application methods, and reasons for pre-wetting.

1. Some common liquid solutions include:
   - Water
   - Salt brine
   - Calcium chloride
   - Magnesium chloride
     (Products such as: Freezeguard, CG-90)
   - Calcium magnesium acetate (CMA)
2. A few common methods of pre-wetting include:
   - Inject liquid into the stockpile
   - Spray loaded truck box with liquid
   - Carry liquid and dispense into the truck auger or spinner during application

3. Some reasons other agencies are pre-wetting include:
   - Reduced salt waste by reducing scatter
   - Adhesion of the material to the roadway
   - Adds needed moisture to the salt
   - Speeds melting at lower temperatures
   - Absorbs fine particles to reduce wind loss
   - Adds some initial heat in lower temperatures
   - Salt usage reduction up to 40% with same level of service
   - Reduced corrosion on bridges and vehicles

C. ANTI-ICING BACKGROUND

Several other states (New York, Ohio, Washington, Colorado) and countries (Sweden, Finland, Norway, Switzerland) have tried or are currently using anti-icing techniques as part of their normal snow and ice operations. There are a number of different liquid solutions, application methods, and reasons for anti-icing.
1. The common liquid solutions include:
   - Water
   - Salt brine
   - Calcium chloride
   - Magnesium chloride
     (Products such as: Freezeguard, CG-90)
   - Calcium magnesium acetate (CMA)

2. A few common methods of anti-icing are applying the following materials prior to or early in a storm event:
   - Dry salt
   - Pre-wetted salt
   - Liquid materials

3. Some reasons other agencies are anti-icing:
   - Reduce/eliminate compaction
   - Less equipment wear from removing compaction manually
   - Reduce salt usage by preventing the ice bond
     (rather than de-icing)
   - Reduced corrosion

D. FIELD STUDY OVERVIEW

1. Camden Pre-Wetting Field Study

Dry salt was pre-wetted using a commercial liquid product of the Great Salt Lake Minerals & Chemical Corporation called Freezeguard (27% magnesium chloride, 5% lignin based corrosion inhibitor, 64% water) to determine if salt usage could be reduced during de-icing operations. Two hopper box tandem dump trucks with hydraulic liquid dispensing units were used on four centerline miles of I35W from junction I94 to the junction of Industrial Boulevard in Minneapolis. At the completion of 24 storm events, we found that pre-wetting with 6% liquid
Freezeguard (by weight), may reduce salt usage from 10 to 25%. The operators slowly developed a confidence in pre-wetting with Freezeguard and using the hydraulic equipment. They question whether this is the most economical method in warmer temperatures (above 15 degrees Fahrenheit). Since Freezeguard costs $.70/gallon, we would need to consistently reduce salt usage by 20% to pay for the 6% liquid Freezeguard added (No anti-corrosion benefits considered). The amount of reduction needed could be reduced if large quantities of Freezeguard were purchased at a lower price or if salt prices should increase. Those involved in the study do not recommend implementing the process on a large scale at this time but recommend continued testing of Freezeguard at temperatures below 15 degrees F.

2. Lakeville Pre-Wetting Field Study
Dry salt was pre-wetted using a commercial liquid product of Cargill, Inc. called CG-90 (27% magnesium chloride, 5% corrosion inhibitor, 66% water) to determine if salt usage could be reduced during de-icing operations. A mainline tandem dump truck was set up with a 120 gallon fiberglass tank with a gravity flow system for dispensing the liquid onto the spinner. This tandem was used on six centerline miles of I35E from the junction of I35W to the junction of Cliff Road. This section was broken into three different two mile test areas for each direction. At the completion of 23 storm events, we found that pre-wetting with a minimum of 7% liquid CG-90 (by weight) may reduce the salt usage from 10 to 20%. Future tests should have a portion of the control area use the same salt reduction as the test area to see if pre-wetting was the actual cause of the reduced salt usage. As in Camden, the operators slowly developed some confidence in the product and equipment, but question if a more economical liquid could be used in warmer temperatures. Since CG-90 costs $.55/gallon, we would need to consistently reduce salt usage by 15% to pay for 7% liquid CG-90 added (No anti-corrosion benefits considered). The amount of reduction needed could be reduced if large quantities of CG-90 were purchased at a lower price or if salt prices should increase. Those involved in the study do not recommend implementing the process on a large scale at this time but recommend testing CG-90 in colder temperatures (below 15 degrees). They also expressed an interest in trying salt brine for pre-wetting in warmer temperatures. The greatest problem encountered during this test was adjusting the ground oriented salt/sander controllers in order to uniformly reduce salt use from each successive setting.
3. Plymouth Anti-Icing Field Study

Liquid salt brine (21% sodium chloride, 79% water) was applied directly to the highway using a European liquid spreader (EPOKE) several hours prior to an anticipated storm to determine if this could reduce the ice to pavement bond, thereby reducing the amount of salt used to de-ice. A flatbed truck with a 1600 gallon tank and a liquid spreader was used to apply from 30 to 60 gallons of salt brine per lane mile. Salt brine was applied on four different test areas within twelve centerline miles of T.H. 55 from I494 to T.H. 100. After 12 storm events, we found applying the salt brine prior to the storm did not change the amount of salt the operators applied because the salt brine only kept the road bare wet or slushy for an hour or two into the storm and most of the time the roadway condition looked the same to the operator by the time they were called. Even though the road looked the same, Mn/DOT field observers noticed the slush was easier to remove in the salt brined areas. Further investigation into adding a slush plow attachment to snow removal equipment may produce improved results using salt brine. We did not get to test heavy frost conditions, but our experience with salt brine shows it has potential for treating frost. As a spin off of this test area, the operators suggested using salt brine for pre-wetting dry salt. We acquired two commercially manufactured tailgate mounted pre-wetting systems with electrical pumps. These two systems were mounted on two tandem dump trucks assigned to I494. Initial results of pre-wetting with salt brine shows potential for success, especially in warmer temperatures. Those involved in the field study recommend the continued study of the use of salt brine for pre-wetting and possible direct liquid applications for anti-icing, de-icing, and frost.

E. GENERAL RECOMMENDATIONS

The following are generalized recommendations with more specific details outlined in the recommendation section for each sub-area.
1. **Calibration of Ground Oriented Sand/Salt Controllers** - Our greatest problem during the field studies was obtaining test vehicles capable of incrementally reducing sand/salt use in small uniform amounts. After detailed studies, we determined that to adjust the controllers from 200 pounds/mile to 1000 pounds/mile in uniform increments, it was necessary to install new electronic resistors in the controller switches. New switches should be installed in all metro vehicles that do not have relatively uniform increments from 200 to 1000 lbs/mile or that can not be adjusted using the standard procedures currently utilized.

2. **Pre-wetting Chemical** - Increased emphasis should be placed on the use of salt brine. It has the greatest potential for success because it can be made from the salt in our shed at a very low cost compared to other chemicals used. Early indications are that it may work equally well in warm temperatures. In addition, there is potential for recycling water already containing salt such as salt pile runoff, truck washwater, stormwater holding ponds, or municipal water softener plants. Lower freezing point chemicals such as Freezeguard, or CG-90 could be studied further for use in colder temperatures (below 15 degrees fahrenheit). Otherwise, an economical liquid solution could possibly be made by adding only the appropriate amount of dry magnesium chloride or dry calcium chloride required for the temperatures of the storm event while making our salt brine.

3. **Pre-wetting Equipment** - We do not recommend the large scale purchase of pre-wetting equipment at this time. Additional systems should be acquired for smaller scale implementation or for further testing. Greater emphasis should be placed on using or enhancing simple pre-wetting equipment such as the gravity feed or electrical pump systems. Electrical systems show the greatest potential due to their lower cost, consistent liquid flow, better mixing at the auger, and the potential to add attachments for other purposes such as washing ramp signals or traffic signs.

4. **Anti-icing Equipment** - At this time, we do not recommend the purchase of equipment like the EPOKE (European liquid spreader) unless it can be factory modified to meet our desired higher application rates at lower ground speeds. Due to the low maximum volume of liquid that can be applied (30 gallons/lane mile) and because of the speed required to build up pump pressure, this equipment has limited additional uses and is quite costly ($24,000). We
recommend setting up a used tandem dump truck with a 2500 gallon tank mounted directed on the frame. There should be a pump system with attachments for use in spraying salt brine in the winter, applying water in front of the road sweeper in the spring, and for cleaning bridges the remainder of the time. This vehicle could also be equipped with a European slush plow or rubber underbody blade for removing slush. This would allow multiple use of the same vehicle thus increasing cost effectiveness.

5. Further Testing - We recommend setting up similar future tests in the Camden and Lakeville areas. In these tests, observers should only be called when temperatures are below 15 degrees F. Additional details are included in each area’s recommendations. A study area should be developed in the Plymouth sub-area to test salt brine using electrical pump pre-wetting systems. In addition, another study area should be set up in the Plymouth sub-area to test the use of the tandem dump truck with the 2500 gallon tank described previously. This tanker could apply salt brine prior to the storm (anti-icing), during the storm (de-icing), and for frost events to evaluate the effectiveness of salt brine. If any testing is to be done next year, a project coordinator should be identified as early as possible. People that were involved this year should be involved again next year for continuity and to build on the knowledge already gained.

For Additional Information Contact:
Paul Keranen,
Maintenance Operations Research Engineer
395 John Ireland Blvd.
St. Paul, Minnesota, 55155
(612) 282-2281