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Maintenance Technology Project

2003-2004: 8th Season

The Maintenance Technology Project supports the Operations Division strategic direction of promoting the use of leading-edge technology, materials and equipment for winter operations on provincial highways, to ensure that maintenance operations use road salt, plows and spreaders effectively in providing safe winter driving conditions.

While the Elsinore Patrol on Highway 21 in Owen Sound Area continues to be the focus of test and evaluation activity, the scope of investigations has increased by engaging Area Maintenance Contractors and other Managed Outsource areas as partners in technology evaluation throughout Ontario. Specially trained staff and equipment are in place at Elsinore to monitor the safety and effectiveness of innovative products, systems and approaches using video cameras, environmental and friction sensors. These technologies measure effectiveness objectively and ensure that safe conditions are maintained while tests are in progress. Testing equipment is deployed at scheduled times to facilitate evaluations in the partner-operated areas. Improvements to the test and monitoring equipment this year include a fully web-supported video surveillance and archiving system, improvements to friction trailers, and a fully enclosed salt storage and loading facility.

Once established under test conditions and reviewed by stakeholders, innovations are implemented on a pilot scale and subject to continued review and evaluation. These innovations are then implemented in phases across the province.

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Project Test Site

Location

A 50 km section of Highway 21, between Owen Sound and North Bruce, that includes the communities of Jackson, Alvanley, Allenford, Elsinore, Chippewa Hill, Southhampton and Port Elgin.

Site Geography

- Weather systems from Lake Huron and Georgian Bay, due to location at the base of the Bruce Peninsula;
- High snowfall (annual average 2.5 to 3.5 meters, falling on 45 to 75 days per year), a shorter winter thaw than most areas of southern Ontario, and areas of severe drifting;
- A variety of snow and frost conditions representative of most severe winter areas of the province, partly due to diverse topography and land cover (rolling uplands, flat lowlands, forested and open areas, and swamps);
- Moderate traffic levels and highway speeds provide safer testing conditions than more densely populated areas of southern Ontario.

Test Sections

- Eight test sections with an automated measurement site at the midpoint of each;
- Changes in snow cover and surface friction monitored intensively in all sections;
- ARWIS sensors and video cameras at test sites can be viewed remotely on the web;
- Weather and snow conditions at all measurement sites are recorded every 10 minutes.

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2002-2003 Key Results

1. Maintenance Technology Test Site

A data set of 287 tests from winter season 2001/02 was completed and prepared for analysis.

Three hundred and ninety tests were completed in the 2002/03 season due to a very snowy February. They included the following comparison types: granular salt application rate, sand application rate, pre-wet liquid type, pre-wet liquid application rate, pre-wet sand, salt/sand mix, salt spread width; Direct Liquid Application (DLA) application rate, liquid type; salt size gradation.

The 2002/03 data will be compiled in a format similar to the 2001/02 data and then both sets will be analyzed together to provide support for decisions on technology implementation and Best Practices updates.

Test data from past years has been placed on a web site operated by the [AURORA](#)* program:

[Expert System for Maintenance Decision Support](#) (PDF - 735 K)**

New data will be added as it becomes available.

2. Advanced Road Weather Information System (ARWIS)



MTO ARWIS network in Southern Ontario

Advanced Road Weather Information Systems provide real-time measurements and site-specific forecasts of weather and pavement surface conditions, including temperature and frost formation. Information from ARWIS is needed for effective use of Direct Liquid Application (DLA) and other winter maintenance operations. Implementation of a Ministry-wide ARWIS program began in 2000. As of fall 2003, 82 ARWIS sites are in operation on provincial highways. Another 30 sites are currently being installed.

MTO is involved in research and testing of ARWIS through the AURORA partnership of Canadian, U.S. and Scandinavian highway agencies, and is leading a project to measure and compare the accuracy of forecasts in different parts of the world. This will help in setting expectations for forecast accuracy and will provide guidance on how to use the forecasts in planning DLA operations.

3. Pre-wetting and Direct Liquid Application, Monitoring of Pilot Implementations

Pre-wetting and Direct Liquid Application (DLA) are alternative methods of applying salt to enhance plowing and remove snow in winter. Pre-wetting involves the application of a small quantity of liquid to salt granules as they are spread on the pavement. Pre-wetting improves the performance of salt by reducing bounce and scatter loss from the pavement, and by increasing the melting rate at which the salt dissolves into brine, enhancing its ability to melt snow and ice. Implementation of pre-wetting across the province began in 2000 and has now reached 59% of the spreader fleet used on provincial highways. All of MTO's new spreading contracts require that spreaders be equipped with pre-wetting capabilities.

A variable application rate system for pre-wet salt was developed from earlier years' test data, resulting in reductions in salt application exceeding 20% under certain conditions with improvement or no change in service levels. Salt reductions associated with the switch from dry to pre-wet salt across the province are being tabulated from maintenance records for the 2002/03 season, and the 2001/02/03 test data from Elsinore will be analyzed to determine whether additional reductions are warranted.



Two-lane Direct Liquid Application by tanker truck

Pre-wetting is also being used to assist sand in adhering to ice and snow pack when the temperatures are too low for salt to be effective, reducing the number of applications of sand required to maintain traction on the road surface.

DLA is the application of liquid chemical sprayed directly onto the road surface. The chemical prevents the formation of frost and black ice and prevents snow and

ice from bonding with the road surface. Pilot implementation of DLA began in Eastern Region in 2000, and has now expanded to 9 patrol areas across the province. It has generated a positive response from MTO staff and contractors, improving service levels and reducing the number of full salting and sanding trips where it is used by as much as 30%. Experience gained during the pilot implementations suggest that application rates can be reduced and that effectiveness can be enhanced in some conditions using lower rates. These rates are being tested at Elsinore and elsewhere under closely monitored conditions. Lower rates may also decrease costs by reducing the number of spreaders needed to cover a route.

DLA is being applied in response to forecasted weather conditions which will yield the maximum benefit to the public.

Data on the costs and effectiveness of pilot implementation of Pre-wetting, Direct Liquid Application and Fixed Automated Spray Technology systems were obtained from patrol records and from MTO's Maintenance Management Information System. These are being compiled and analysed to guide future implementations.

4. Fixed Automated Spray Technology (FAST)

FAST is a DLA system that is built into highway bridges. The system automatically sprays anti-icing liquid on the pavement prior to frost and black ice formation or snow accumulation. FAST installations are particularly effective at locations that tend to ice early and are difficult to monitor at frequent intervals. The FAST systems consist of an ARWIS station that provides sensor data, and computer logic systems to trigger the spray when icing conditions are anticipated.



FAST System on Bridge Deck

Since MTO's first FAST was installed on an interchange ramp between Hwy. 401 and 416 in 2001, there have been no weather related winter accidents at that site. Five sites are now operational and additional sites are planned. A review of the operation of the first site was undertaken to identify improvements to the logic that triggers the spray. These continue to be modified as we learn more about the

systems.

5. Salt spread pattern and spreading speeds

Salt spread pattern has become an issue as winter maintenance becomes more proactive. Placement of dry salt is normally most effective near the crown of the road, providing high concentration of material to create a bare wheel track and allowing brine to flow across the pavement and prevent snow from freezing to the surface. Where salt is applied in advance of snow accumulation, broadcasting across the pavement may be more effective. Tests are underway to identify the most effective spread pattern for different snow conditions, spreader types and operating speeds that can achieve those patterns.



**Rear-discharge spreader
broadcasting salt across one lane**

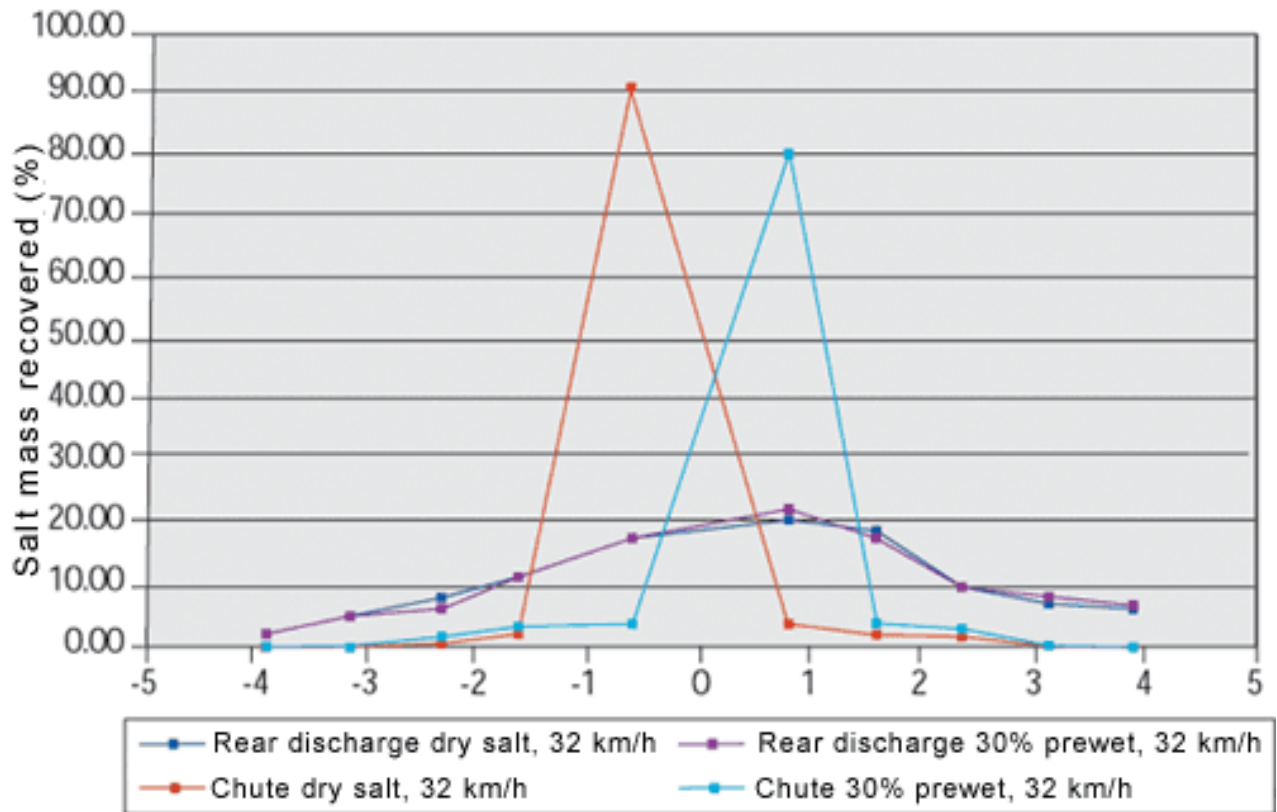


**Side-discharge spreader
placing salt at centreline**



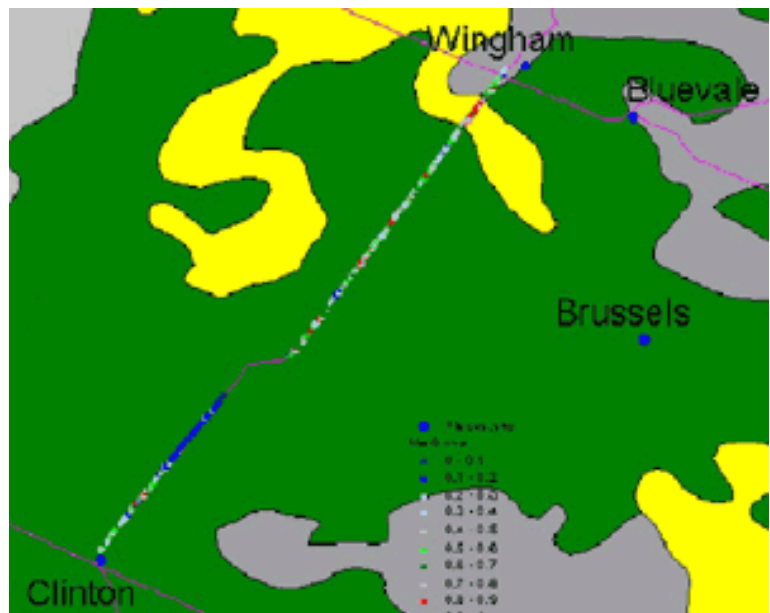
Snow melt measurement test

Salt spread pattern, Centralia, low speed



6. AVL Implementation

Global Positioning System (GPS) technology has been integrated with salt spreader controllers to develop an Automated Vehicle Location (AVL) system for highway maintenance operations. It allows highway maintenance agencies and contractors to track the location and operation of patrol trucks, plows and spreaders on a computer screen as they travel down the road, and automatically create records of plowing, salting and sanding operations.



Map of road surface friction during a snow storm using GPS data

AVL has applications in planning and monitoring winter operations, line painting, weed spraying, and other maintenance activities. A pilot implementation began in 2001 and approximately 15% of the MTO contract fleet is now equipped with AVL. A committee is investigating the development of automated queries to provide data in formats commonly needed for highway maintenance operations.

AVL is used at the Maintenance Technology Project test site to provide accurate records of plowing and salt spreading at each of the test sections. It is also used to aid in locating and mapping mobile video and friction data, as well as infra-red thermometer data.

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Overview of Implementation

Implementation Strategies

New technologies and innovations that prove successful are incorporated in ministry operational practices through technology transfer to the private sector.

Vary by Location and Type

Implementation strategies vary by location and type of service delivery, and are facilitated through:

- Innovation Proposals submitted by Area Maintenance Contractors (AMC's)
- Ministry direction to AMC or Managed Outsourcing (MO) contractors

Variable Salt Application Rates

Salt application rates as low as 50 kg/2-lane km are now being used under suitable conditions when the salt is pre-wetted with a liquid de-icer. The lowest rate formerly recommended for dry rock salt was 130 kg/2-lane km.

Pre-wetting equipment is now installed on 157 spreaders at 71 patrol yards across the province. In addition, 16 spreaders at 9 patrol yards are outfitted for Direct Liquid Application (DLA). A special monitoring program is in place to help measure the benefits of pre-wetting and antiicing and to identify and resolve practical problems with implementation.

A specification for liquid de-icing and anti-icing chemicals was developed to ensure that all liquids used are safe and effective and that tenders can be evaluated on a price per performance basis.

The original Fixed Automated Spray Technology (FAST) site is operating effectively and 4 additional sites have recently been added. More sites are planned for future years.

AVL

Currently there are 150 winter maintenance vehicles equipped with AVL and can be tracked in real-time on an internet-based system. MTO will be adding 85 more units this year. All spreader and operations data collected by the AVL are archived and can be used to generate reports for contract administration. 5 automated patrol diary computers are being tested.

ARWIS

Thirty new sites are being added this winter bringing the total to 112.

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2003-2004 Test Plan

Pre-wetting

Objectives: Continue acquisition of test data on the effectiveness of alternative anti-icing liquids and application rates. Analyse the data to recommend minimum effective application rates and to improve chemical performance specifications.

Winter Sand

Objectives: Continue evaluation of traction and retention improvement using different sand size gradations and with pre-wetting.

Direct Liquid Application (DLA)

Objective: Measure effectiveness of proactively applying anti-icing liquids in reducing total quantity of road salt and winter sand required to meet bare pavement standards on a storm by storm basis. Investigate cost-benefit ratio compared with standard pre-wetting operations.

Effective Spreading

Objective: Reduce loss of salt to the environment through better control of spreader discharge patterns.

Salt Storage and Recycling

Objective: Monitor the quality and quantity of vehicle washwater at a patrol yard and evaluate the potential to recycle it as antiicing liquid.

Plow Blades

Objective: Investigate effectiveness and service life of innovative plow blades.

Smart Spreader

Objective: Continue feasibility investigation of automated control functions for combination plow/spreader including dynamic control of application rate and placement, plow position and surface condition monitoring.

ARWIS (in conjunction with AURORA)

1. Benchmark the accuracy of Road Weather forecast products.
2. Investigation of the variability of snow cover conditions along a maintenance route using surface friction to measure snow cover.

Winter Index

Objective: Rate the severity of winter weather conditions to assist in analysis of salt use, expenditures and service level.



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