
# MDOT Winter Operations Liquid Use Plan

# MDOT WINTER OPERATIONS LIQUID USE PLAN

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## *FOREWORD*

It is our hope that these guidelines will lead to the initiation of an effective winter operations liquid use program for anti-icing and deicing in the state of Michigan. A liquid use program can only be effective when used in conjunction with existing Winter Operations procedures.

This guideline promotes the use of liquid chemicals to:

- Anti-ice the roadway
  1. Prior to a storm
  2. To prevent frost on bridges
- De-icing the roadway with pre-wetted salt to
  1. Increase the effectiveness of salt
  2. Reduce salt usage
  3. Reduce abrasive usage

Anti-icing with liquid chemicals prevents the bonding of ice and snow to the pavement or bridge surface. When applied in anticipation of a storm, anti-icing increases the reaction time available to begin traditional maintenance operations. Also, anti-icing liquids can be applied on bridge decks on a regular basis to prevent the formation of frost. This tool has been used by maintenance workers in most winter states, some for more than ten years. Most states with liquid anti-icing and de-icing programs have found them to be very successful.

Pre-wetting rock salt with liquids allows the salt to work faster and at lower temperatures, thus increasing its effectiveness. Also, fewer abrasives are used because prewetted salt works at lower temperatures. Studies have shown that more pre-wetted salt stays on the roadway than traditional “dry” salt when being applied out of a hopper, thus, the application rate of prewetted salt can be reduced.

These guidelines were written to help the State of Michigan implement and effectively use these technologies.

## *INTRODUCTION*

There are two distinct ice control strategies that make use of liquid chemicals: anti-icing and de-icing. Anti-icing operations are conducted to prevent the formation or development of bonded snow and ice to the pavement for easy removal. Anti-icing is done in anticipation of a storm. De-icing is the traditional method of waiting for a storm to hit and then reacting to it. De-icing can also be used in conjunction with anti-icing to form an overall winter operations strategy. De-icing makes use of liquids by pre-wetting salt, making the salt more effective.

### 1.1 Liquid use in Anti-Icing

The first step in any Winter Operations plan should be to use anti-icing technology to prevent the formation or development of bonded snow and ice by timely applications of liquids. Doing so will provide snow and ice control managers with three major advantages:

- The capability of maintaining roads in the best condition possible during a winter storm,
- The capability to do so in an efficient and effective manner; and
- The potential to increase traffic safety.

To best achieve the benefit of anti-icing, maintenance teams should have and use information from accurate and frequent weather forecasts. Also, information from a Road Weather Information System (RWIS) should be utilized where it is available. Using frequent and accurate forecasts along with anti-icing will make our snow and ice control operations:

- Anticipatory in nature
- Proactive in management; and
- Prompt in response

### 1.2 Liquid use in De-Icing

De-icing operations, on the other hand, tend to be reactive instead of proactive. Therefore, current snow and ice control operations require a larger quantity of salt to work its way through the snow pack. Reactionary de-icing efforts require less judgment than pre-emptive anti-icing, because you are able to see the conditions you must respond to. However, being reactive results in delays, higher materials costs, additional man hours, and usually a lower Level of Service (LOS).

One way of lowering the costs and/or raising the LOS associated with de-icing is to pre-wet the salt. By pre-wetting, less salt can be used to achieve the same LOS and in a shorter amount of time. In colder temperatures less abrasives are used because pre-wetted salt is effective at lower temperatures than traditional salt.

Nevertheless, the use of standard de-icing techniques, with or without prewetting, remains an important part of any winter operations plan. This is especially true on roads with lower service levels and/or long route distances that will not allow for the practical use of anti-icing operations.

## 1.3 Purpose of these Guidelines

These guidelines provide information for the successful implementation of an effective anti-icing and pre-wet program using liquid chemicals. It is intended for use by all those involved in winter operations. Some of the ideas presented may not apply in all situations. These guidelines are a "living" document, subject to change and improvement as more is learned about using liquid chemicals and other methods of winter operations to manage snow and ice.

These guidelines were written to help winter maintenance teams develop an effective strategy for maintaining roads in the best condition possible during a winter storm. They describe significant factors that should be understood and must be addressed in any anti-icing and prewet program. The development of a winter liquid chemical program must be based on each maintenance team's specific needs and be reasonable and economical. All programs must focus on weather forecasting information, materials, and methods that take into account LOS, current weather conditions, and traffic volumes as well as available personnel, equipment, and materials.

# Chapter 2

## *ANTI-ICING*

This chapter presents recommendations for successful anti-icing practices. It presents information that will assist in the development and the implementation of a systematic anti-icing program. The chapter is organized into six sections to give recommendations and procedures from the time an anti-icing program is initiated to a postseason analysis of the program.
The six sections in this chapter are:

1) Getting Started
2) Preseason
3) Prestorm
4) During the storm
5) Poststorm
6) Postseason

## 2.1 Getting Started

No short discussion or list of recommendations can completely cover the wide range of weather conditions facing agencies state-wide. Therefore agency managers should use these guidelines as a starting point for developing their own anti-icing program, to accommodate local experience, specific site concerns, and agency objectives.

## 2.1-A Equipment/Materials

### *Automated Systems*

Automated anti-icing systems use sensors in the pavement to monitor conditions and activate a spray system for anti-icing liquids when the pavement approaches freezing.

Automated systems may be cost justified in areas where frosting or freezing may present the most hazards. Examples of places where a spray system may be justified are bridges, sharp curves, and steep hills.

### *Tankers*

Highway agencies interested in beginning or experimenting with an anti-icing program might consider modifying some existing spreader equipment before investing in new equipment. When modifying dump trucks for a anti-icing program. It is recommend that a 1,250 gallon tank be used in single axle dump trucks and a 2,000 gallon tank in tandem axle trucks.  Consideration should be made for baffling tanks over 1,000 gallons. Also asphalt distributor trucks, liquid fertilizer spreaders, and weed control spreaders have been successfully modified and used in anti-icing programs. Trailer mounted tanks can also be used. Another option is to purchase a new or used semi-trailer for an anti-icing program

**Figure 1: A semi-trailer equipped for anti-icing**

### *Application Equipment*

When applying liquids, streamer nozzles 1/4" or more in diameter should be used in order to prevent clogging due to suspended solids in the solution. Fan nozzles are not recommended as they spray the entire road surface with liquid, potentially making a slippery road. Streamer nozzles will apply the liquid in evenly spaced increments (see Figure 2). To allow for proper distribution of the anti-icing liquid on a roadway the streamer nozzles should be placed 10”-14” apart on the spray bar.

Adjustable height applicator bars will allow operators to minimize the effect of wind and air turbulence from the trucks. Placing rubber mats on either side of the spray bar will also minimize over-spray. Rubber hoses that are just long enough to touch the ground can be put over the spray nozzles to apply the liquid at the road surface.

**Figure 2: Anti-ice rig equipped with rubber application hoses**

### *Storage Tanks/Pumps*

Tank walls should be rated 12 pounds per square inch or be capable of handling liquid with a specific gravity of up to 1.6. All tanks should be placed on a flat concrete surface and installed according to manufacturer's recommendations. Fill and discharge openings in the storage tank should be three inches (3") in diameter and accept cam lock fittings. The tank should be vented and labeled with the name of the liquid being stored inside. If the tank is to be filled from the top, an anti foam agent needs to be mixed in the liquid to prevent foaming while filling. It is not recommended that the tanks be made of any type of metal due to the corrosiveness of some anti-icers.

Pumps should be constructed out of corrosive resistant materials and be capable of pumping liquids with a specific gravity of 1.6 or greater.

### *Chemical Storage*

All anti-icing and de-icing chemicals should be stored under cover or inside a building. It is important to utilize good housekeeping practices in and around all chemical storage facilities to ensure chemicals are not exposed to weather.

### *Chemical Containment*

Consult your local regulatory agency, as to proper storage and containment of anti-icers and de-icers. Abide by all local, state, and federal laws and/or guidelines.

### *Choosing a liquid*

Choosing a material for use in snow and ice control is not simple. Some agencies opt to use different materials for different conditions and many agencies are not able to use some materials due to environmental restrictions, cost, or availability of the products.

Deciding which material is best can only be done by proper evaluation, proper use, and input from the public. The exact liquid evaluation process should be determined by each individual agency. There are many resources that can be consulted before choosing a liquid. A selection of resources can be found in Appendix 1.

A policy outlining how the operations are to be done, modifying this document to meet your specific needs, a training program for the crews, informing the public, use and evaluation of new and innovative materials, and proper planning will help control costs, improve efficiency, and make your job easier.

## 2.1-B Chemicals/Materials

Five chemicals have been used for liquid anti-icing treatments nation wide: sodium chloride (NaCl), calcium chloride ($CaCl_2$), magnesium chloride ($MgCl_2$), potassium acetate (KA) and any of the chloride products combined with an Agricultural Bi-Products (ABPs). Some important properties of these chemicals are given in Table 1: Properties of anti-icing chemicals. Not all products/suppliers are listed in Table 1.

**Table 1: Properties of anti-icing chemicals**

| Liquid Category | Minimum freeze point, °F (for storage characteristics) | Concentration (Percent) | Ice Melt Capacity at 15 °F (grams ice melted per gram deicer) | Performance Ratio (24% salt brine = 1.0) |
|---|---|---|---|---|
| **Magnesium Chloride Based Liquids** | | | | |
| Magnesium Chloride Brine | -27 | 22 % | 0.58 | 2.1 |
| | -6 | 26 % | 0.72 | 2.6 |
| Caliber M-1000 | -79 | 30 % | 0.60 | 2.2 |
| **Calcium Chloride Based Liquids** | | | | |
| Calcium Chloride Brine | -60 | 30 % | 0.35 | 1.3 |
| | +30 | 36 % (dust palliative) | --- | Don't Use !! |
| LiquiDow Armor | -40* | 30 % | n/a | n/a |
| Ice Ban CM-80 | -67* | 28 % | n/a | n/a |
| **Sodium Chloride (Rock Salt) Based Liquids** | | | | |
| Salt Brine | -6 | 24 % | 0.28 | 1.0 |
| **Other** | | | | |
| Potassium Acetate (KAc) | -70 | 50 % | 0.9 | 3.2 |
| CMA | -10 | 30 % | 0.0 | 0.0 |

* Agitation is required!

## 2.1-C Source of Weather and Forecasting Information

Having and using weather and forecast information is one of the keys to successful and effective anti-icing. Reliable weather and forecasting information can help make the decisions of when to anti-ice and what treatment to apply much easier. Forecasting information should include; when the precipitation is expected to start, its form, the probable air temperature, the temperature trend during and after the storm, and the wind direction and speed. Current weather information should include the air and pavement temperatures, dew point, wind speed and direction, and precipitation form. A few sources of weather and forecasting information are described below.

### *National Weather Service*

The National Weather Service is the easiest and cheapest way to access weather information. This information is readily available for any geographic area, and can be accessed by internet, radio, and cable television.

### *Nowcasting*

Nowcasting refers to the use of real-time data for short-term forecasting. It relies on rapid transmittal of pavement and weather data from RWIS installations, radar, field observations and any other information source for making a judgment of the probable weather and pavement condition/temperature over the next hour or two. Nowcasting brings all available information together for proper decision making.

### *Road Weather Information System*

RWIS is an integrated wide-spread network of weather data gathering and pavement condition monitoring systems built to provide information winter operations managers can use to make operational decisions. The most visible components of the RWIS are the roadside installations of the system. A single site, which includes several pavement and subsurface sensors, is referred to as a Remote Processing Unit (RPU) or an Environmental Sensing Station (ESS). The RPU consists of atmospheric sensors mounted on a 30-foot tall metal tower, pavement sensors embedded in the pavement surface and beneath the surface, an enclosure containing the computer processor and the required communications components.

Data from the pavement and weather sensors are formatted at the RPU, transmitted to the central processing unit (CPU). Each CPU has a separate computer directly attached to it and a modem through which information is provided to remote users.

### *Satellite Transmitted Weather Information*

Weather can also be transmitted to each garage via satellite. This system usually requires an upfront set up fee and a monthly charge for the weather information.

## 2.2 Preseason

## 2.2-A Order Materials

Anti-ice liquids need to be ordered and delivered before the season begins. In Michigan, direct maintenance facilities, as well as counties and cities that have maintenance contracts with the state can purchase from the DMB contract. Generally the prices from this contract are cheaper than what would be paid if the counties or cities purchased these items on their own.

## 2.2-B Calibrate Equipment

In order to work efficiently all liquid distribution systems need to be calibrated on at least an annual basis. Calibration should be done to the manufacturer's recommendations.

## 2.2-C Training

It is essential to have trained personnel before starting an anti-icing program. The crews performing anti-icing operations should receive training pertaining to: when and when not to apply chemical, proper application rates for different conditions, how to operate the new equipment, and how to track their results using a TAPER log. It is also important to have a yearly refresher training.

Everyone resists change, but change, in most cases is required for an anti-icing program to be successful. Training of operators and managers is very important when moving into this area of technology. An anti-icing program will require more information for making earlier informed decisions and may involve different methods and materials than do conventional methods. This will require an emphasis on training.

## 2.2-D Acceptance Testing/Quality Control

Each garage or agency needs to develop a way of testing anti-icing liquid before it is delivered to the storage site. The tests need to be simple enough that they can be carried out at a garage when a load of chemical is delivered. Of the available tests, viscosity and specific gravity are the simplest and easiest to perform. Significant deviation in test results from expected values will signal a problem with the product. Since theses tests can be conducted upon delivery, suspect loads do not have to be accepted and thus will not contaminate an otherwise “healthy” supply.

## 2.3 Prestorm

### *Deployment of personnel*

Use of modern weather forecasting information will provide more time in advance of a storm to plan operations. With better information, maintenance teams can more efficiently determine standby status and inform personnel with more lead time. Timely weather information is essential when making effective crew call out decisions. This is especially important for anti-icing operations as the timing of the initial treatment is critical. By minimizing the mobilization time, managers can reduce the call in time of the entire crew and extend crew availability.

### *Information assembly*

The initial anti-icing operation is most often the application of liquid to the pavement in advance of the storm. However, before this action is taken, information about the nature and the characteristics of the anticipated storm should be assembled and a decision made concerning the action. Several pieces of information need to be assembled upon first notice of a winter storm. The information includes weather forecasts, color weather radar data from the weather centers or through modem access, and where available, RWIS data. Special attention should be paid to the areas in your vicinity that may have already been affected by the approaching storm. The information can be used to estimate locally when and where the event will begin, its extent, severity, and impact.

The timing of the initial anti-icing application should be made in anticipation of worsening pavement conditions. The effectiveness of anti-icing is dependent on the amount of liquid placed, the amount of moisture received prior to the storm, and displacement of the liquid by traffic. Residual salt from previous operations has a short-lived effect on highway conditions at the beginning of storms and should not be relied upon as an initial anti-icing operation.

### *Decision point*

After reviewing the information, managers must decide when to initiate treatment and what type of treatment to apply. They make their decision based on a combination of many factors:

- When precipitation is expected to start
- Form of precipitation
- The probable air and pavement temperatures
- The anticipated trend of the temperatures
- The expected sky conditions
- The wind speed and direction
- The intended timing of the treatment
- Traffic considerations and timing

### *Traffic*

Although traffic density has an effect on friction, it is not as direct or consistent as the effects of precipitation type, precipitation rate and pavement temperature. In fact, anti-icing operations have been shown to be successful in high volume rush hour traffic, as well as low volume, middle-of-the-night traffic. The routine use of traffic information should be mostly to ensure that anti-icing operations are completed ahead of rush periods in order to avoid delays which can lead to bonded snow pack or ice. Local experience or LOS may warrant incorporation of traffic information within an individual agency's anti-icing operational guide.

### *Wind*

Experience has shown crosswind speeds in excess of 12 to 15 MPH may cause drifting across a pavement and retention of snow if the pavement is wet. The threshold wind speed at which this becomes a problem will vary widely with the road site and other conditions. Highway maintenance personnel should be alert to the conditions that may cause interception of snow and incorporate the information in their operations.

When a decision is made to apply liquids during windy conditions, experience has shown adjusting the sprayer closer to the pavement can be successful in avoiding loss and more closely achieving the desired application.

### *Safety and handling of liquid anti-icers*

Liquid anti-icers stored in unheated tanks will reach temperatures much less than freezing. Therefore, skin contact with the liquid chemicals at these temperatures can result in "instant" frostbite.

Goggles or face shield protection and rubber gloves with long gauntlets should be worn, consult the product's Material Safety Data Sheet (MSDS) for exact handling instructions. All storage and dispensing tanks should be labeled "Liquid anti-icer," as well as using the name of the specific anti-icer. All loading and off-loading should be performed in a safe manner, as close to ground level as possible. Liquid anti-icers are especially harsh on leather articles of clothing.

## 2.3-C Recommended Practices

### *Application*

Operators can spread liquid chemical uniformly over the pavement at relatively fast speeds as a pre-storm treatment. To minimize the amount of bonded snow or ice, the chemical must be applied before enough snow has accumulated to keep the chemical from reaching the pavement or being excessively diluted.

A factor of great importance is pavement temperature. Pavement temperature directly influences the formation, development, and breaking of a bond between fallen or compacted precipitation and the road surface. Also when high humidity levels are accompanied by low dew point temperatures, there will be a potential for formation of frost.

Unless some external source of heat is provided, the pavement temperature will generally track air temperature with a time delay. For road sections without obstructions to the sky, solar radiation during the day and exposure to the clear night sky will affect the road surface temperature more than on sections influenced by air contact only.

Type and rate of precipitation and pavement temperature are the most important variables to consider when performing anti-icing operations.

### *Field Observations*

There is no substitute for visual observation of weather conditions and conditions of the pavement surface. Observations remain an important tool for making operational decisions even when there is access to new technology such as RWIS. Although law enforcement personnel can help fulfill this role, trained highway maintenance field personnel are better prepared to judge the severity of conditions and to make or recommend corrective action

**Once the storm begins, anti-icing is finished.**

## 2.4 During Storm

### *Operations*

An initial application of an anti-icing liquid may suffice for some conditions and short duration events, but it is far more likely that other treatments will be required during a storm. When the effects of initial anti-icing efforts begin to fade, operations should switch to standard winter operations.

## 2.4-A Development of Snowpack and bond

Even when anti-icing operations are performed successfully, a snow or ice pack may still develop a bond to the pavement. This generally implies de-icing is necessary. However, it is often observed in practice the previous anti-icing treatments have slowed the development of a bond, resulting in a weaker bond that is more easily broken. This leads to a quicker return to acceptable pavement conditions. Those developing anti-icing programs should recognize bonded snow and ice pack can occur even when anti-icing is "successful", but it will not usually have the strength of bonded pack observed during traditional de-icing operations.

### *Monitoring of conditions*

It is important for pavement and weather conditions, weather forecast updates, and where available RWIS data continue to be closely monitored after the initial anti-icing operation has taken place. Special attention should be paid to pavement temperature, trend, and to changes in precipitation type and intensity. This information, plus observations of precipitation and pavement conditions, as well as evaluations of treatment effectiveness are needed to determine when standard winter operations should begin.

## 2.5 After Storm

Careful recording of conditions and the steps taken in response will provide the basis for fine-tuning the program for specific service levels and conditions.

## 2.5-A Assess effectiveness

To improve both the effectiveness and efficiency of an anti-icing program, each agency should evaluate the performance of its crews and equipment as well as the chemicals. All levels of the agency should be involved in this assessment. Many times, what a supervisor observes during a storm is not readily seen by an operator, and vice versa. Managers should also track the cost and effectiveness of the anti-icing program, and, where possible, compare the results to conventional operations.

To develop valid results, cost data of a storm or weather event must include all costs for materials (chemicals and abrasives), labor, and equipment employed in operations. For chemicals, this includes the purchase price, transportation to storage site, storage, truck loading, handling and mixing of solid chemicals, and solution preparation. For equipment costs the agency must develop hourly rates and multiply them by the hours used. Other costs should be considered, such as the cost of dispatchers, costs of specialized equipment, and cost of patrols, to name a few.

Agencies should measure the costs and effectiveness of the anti-icing and conventional operations separately for specific highway sections or routes. Analysts can then calculate the cost per lane mile for each type of operation, and accurately evaluate their relative success. Most importantly, anti-icing techniques provide the potential for maintaining roads in the best conditions possible during winter storms. Systematic anti-icing practices might or might not reduce overall costs. Cost savings will depend on the current practice: for example, what LOS governs what materials it uses, whether it is more deicing than anti-icing, and the agency's information sources. Examples of success include providing the same level of maintenance effectiveness at less cost, or providing a higher level of maintenance effectiveness at the same cost. To evaluate the costs or success of anti-icing operations, an agency should examine both costs *and* LOS provided to the traveling public.

## 2.5-B TAPER Logs

There is no cure-all application rate for any chemical or any weather event. With every liquid the effectiveness and efficiency of use comes from experience and learning from what you did in the past. The TAPER log is an easy method to track you experiences, and establish application guidelines to meet your needs. A sample TAPER log is included in Appendix 2.
Taper stands for:

- **T** Temperature of pavement
- **A** Application rate
- **P** Product (chemical) applied
- **E** Event (storm) amount and type of precipitation
- **R** Result of snow and ice control activities

## 2.6 Post Season

## 2.6-A Evaluate and improve program for next season

Lessons can be learned from both the successes and failures of snow and ice control operations. Anti-icing is no exception. Improvements in operations and equipment can be identified and implemented through post-season assessment of practices and treatments. Therefore, report anti-icing/ deicing using liquid chemicals for snow and ice control in the daily TAPER log.

Anti-icing with liquid chemicals is expected to result in improved service to motorists and may translate into a financial savings with regard to materials and time necessary to return the pavement to before-storm conditions.

### *Clean-up*

Since most anti-icing chemicals are corrosive all equipment should be washed or flushed after the winter season. Also, the liquid tanks should be circulated according to the suppliers recommendations.

## Chapter 3

## *PREWET*

This chapter presents recommendations for successful prewetting practices. It presents information that will assist in the development and the implementation of a prewetting program. The chapter is organized into six sections to give recommendations and procedures from the time a prewetting program is started to a postseason analysis of the program.
The six sections in this chapter are:

1) Getting Started
2) Preseason
3) Prestorm
4) During the storm
5) Poststorm
6) Postseason

## 3.1 Getting Started

The prewetting of a solid before applying it to the roadway can improve the effectiveness of the solid in most situations. Listed below are a few advantages of prewetting salt.

- The solid chemical is spread more uniformly with less waste from materials bouncing beyond the traffic lane (although not all waste is eliminated);
- Granules adhere to the road surface better;
- There is a faster and longer-lasting effect;
- In some cases the road surface dries more quickly.
- Reduce/eliminate sand usage
- Allows salt to work at lower temperatures
- Application rate of prewet salt can be reduced by 25% to 50% as compared to traditional dry salt.

### 3.1-A Methods

***Prewetting of stockpiles***
This method consists of injecting the liquid chemical into a salt stockpile using spray nozzles that can penetrate into the pile. Typically, the liquid is hauled to the site in a tanker truck and the stockpile wetting is performed by a vendor. The advantages of this method are 1) there is no spray equipment to purchase or maintain, 2) no installation of liquid storage tanks, however, rain or snow on a wetted stockpile will dilute the liquid and cause it to migrate through the pile. It is essential that stockpiles be covered and placed on impervious asphalt or concrete floors. Also, it is difficult to ensure that all the salt is covered with an equal amount of liquid.

***Batching***
This method is essentially the same principle as prewetting the stockpile, just on a smaller scale. Typically enough salt to last through a storm is mixed up and stored until needed. When this stockpile runs out another batch will be made. One problem with this method is that it is possible to run out of stockpiled prewet salt before the storm is over. When this happens crews either

have to be pulled off the roads to make another batch or the garage will have to use regular salt until another batch can be made.

### *Prewetting a loaded truck*

This method of prewetting consists of spraying liquid chemical onto a loaded truck by an overhead spray bar with nozzles that dispense the liquid. The driver pulls his truck loaded with dry chemical beneath a timer-controlled overhead spray bar system. A timer button activates a pump which sprays the loaded truck with the recommended amount of liquid chemical..

There are other variations to this second method. For example, operators can spray the liquid onto each bucket of salt as they load the truck. Some highway agencies opt to use a conveyor system, spraying liquid chemical on the salt as it travels up the belt to the truck. The equipment is very modestly priced.

The one notable disadvantage of this method is that it can have a more corrosive effect on the equipment than dry road salt. Also, it is very difficult to get uniform particle coating with this method as the liquid can channel through the load to the truck bed without coating segments of the dry chemical.

### *Prewetting by spreader spray systems*

Another method of prewetting is through the use of an on-board spray system. A truck equipped for prewetting can apply liquids directly to the material being spread. The prewetting equipment can be an integral part of the spreader design or it can be a system added to an existing truck. Crews can modify an existing truck relatively easily.

As with all spreaders, crews should periodically calibrate the equipment. Operators should investigate any radical deviation in spreader output compared to the control setting (for example, running out before the route is completed, or having material remaining). They should also check for uniform spreading of material. Although a recommended speed of about 35 mph is achievable, drivers should select a speed that yields uniform material distribution. Also, agencies should consider ground-speed controls to achieve as uniform a distribution as possible. These systems modulate the material flow rate as a function of vehicle speed to obtain constant area coverage.

### *Premixed "enhanced" salt*

In some locations, a vendor will offer salt already premixed with an anti-icing chemical. There are several advantages of this method.

- There is no spray equipment to purchase or maintain,
- No installation of liquid storage tanks,
- Reduced corrosion of the equipment since it will contain a corrosion inhibitor.

The one disadvantage of this method is that it is more expensive than regular salt. But, because the salt is prewet, less salt can be used to achieve the same level of service.

## 3.1-B Equipment

### *Prewetting the Pile*
No special equipment is needed because this method is typically done by a contractor.

### *Prewetting a load*
The equipment is modestly priced. The basic components for all truck-load systems are a storage tank, a centrifugal pump, piping, an open spray area, a metering device, and the necessary wiring. The cost of a basic truck-load application system with all new components is between $8,000 to $10,000.

**Figure 3: Prewet unit setup for prewetting an entire truck load at a time.**

### *Spreader spray systems*
Generally the on-board spreader tanks are made of molded polyethylene and are provided with a replaceable output-line screen strainer and shut-off valves. Saddle tank capacity is between 60 to 125 gallons. Both electric and hydraulic spray systems have been used. An electric system consists of a 12V DC electric pump rated at up to 3 gal/min., in-cab controls, one to three nozzles, hoses, spray tank(s) and necessary fittings. A disadvantage of this method is the high upfront cost.

### *Enhanced Salt*
No special equipment is needed for this method.

### *Tanks and Pumps*
Tank walls should be rated 12 pounds per square inch or be capable of handling liquid with a specific gravity of up to 1.6. All tanks should be installed according to manufacturer's

recommendations. All fill and discharge openings in the storage tank should be three inches (3") in diameter and accept cam lock fittings. The tank should be vented and labeled with the name of the liquid being stored inside. If the tank is to be filled from the top, an anti foam agent needs to be mixed in the liquid to prevent foaming while filling. It is not recommended that the tanks be made of any type of metal due to the corrosiveness of some prewetting liquids.

Pumps should be constructed out of corrosive resistant materials and be capable of pumping liquids with a specific gravity of 1.6 or greater.

## 3.1-C Chemicals/Material

***Solid materials and gradation***

Sodium chloride (rock salt) is the solid material most commonly used in winter operations. When deicing, the goal is to get the salt particle to move rapidly through an ice or snow layer to the pavement surface. A larger particle will have greater weight and therefore greater success in penetrating this layer. But if the salt particles become too large it is possible that the salt will damage vehicles traveling behind the salt truck. A salt gradation needs to be specified when purchasing deicing salt to ensure that the salt being purchased is large enough to cut through ice and snow but not so large that it can do damage to vehicles.
The salt gradation suggested by MDOT is attached as Appendix 3.

### *Prewetting solutions*

Five chemicals have been used for liquid prewet treatments nation wide: sodium chloride (NaCl), calcium chloride ($CaCl_2$), magnesium chloride ($MgCl_2$), potassium acetate (KA) and any of the chloride products combined with an Agricultural Bi-Products (ABPs). Some important properties of these chemicals are given in Table 2: Properties of Prewet Chemicals. Not all products/suppliers are listed in Table 2.

**Table 2: Properties of Prewet Chemicals**

| Liquid Category | Minimum freeze point, °F (for storage characteristics) | Concentration (Percent) | Ice Melt Capacity at 15 °F (grams ice melted per gram deicer) | Performance Ratio (24% salt brine = 1.0) |
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| Magnesium Chloride Brine | -27 | 22 % | 0.58 | 2.1 |
| | -6 | 26 % | 0.72 | 2.6 |
| Caliber M-1000 | -79 | 30 % | 0.60 | 2.2 |

| | | | | |
|---|---|---|---|---|
| **Calcium Chloride Based Liquids** | | | | |
| Calcium Chloride Brine | -60 | 30 % | 0.35 | 1.3 |
| | +30 | 36 % (dust palliative) | --- | Don't Use !! |
| LiquiDow Armor | -40* | 30 % | n/a | n/a |
| Ice Ban CM-80 | -67* | 28 % | n/a | n/a |
| **Sodium Chloride (Rock Salt) Based Liquids** | | | | |
| Salt Brine | -6 | 24 % | 0.28 | 1.0 |
| **Other** | | | | |
| Potassium Acetate (KAc) | -70 | 50 % | 0.9 | 3.2 |
| CMA | -10 | 30 % | 0.0 | 0.0 |

* Agitation is required!

## 3.2 Preseason

## 3.2-A Calibrate Equipment

A truck's salt distribution system will not work efficiently if it is not properly calibrated. Calibration is important, because tests have shown that operators cannot accurately estimate the amount of materials being applied by watching it hit the ground through a rear view mirror. The truck's speedometer must be working properly to accurately control the amount of material being applied.

The application rate is variable depending upon the choice of dial settings and speed of the truck. During the calibration process and while applying the material the hopper box gate opening must remain at the same height. Calibration should be done on an annual basis to adjust for any changes in the truck's hydraulic system output. In many cases after calibration, a calibration chart must be filled out and a copy of it attached to the visor of the truck. The calibration chart must contain the vehicle number, various dial settings, and vehicle speeds for applying selected pounds of material per lane mile. MDOT has a separate calibration workbook which explains the step-by-step process of calibrating the solid distribution equipment. This workbook is available from the Maintenance Support Area, Region Support Unit.

## 3.2-B Order Materials

Prewet liquids and salt, along with other prewet related items, need to be ordered and delivered before the winter season starts. In Michigan direct maintenance facilities as well as counties and cities that have maintenance contracts with the state can purchase salt and plow blades from the DMB contract. Generally the prices from this contract are cheaper than what would be paid if the counties or cities purchased these items on there own.

## 3.2-C Training

It is essential to have trained personnel before starting a prewet program. The crews performing prewet should receive training pertaining to: when to apply and when not to apply, proper application rates for different conditions, how to track their results using a TAPER log, and how to operate the new equipment.

Personnel trained in the details of prewetting are essential for an effective program. Prewet techniques and operations are new to many operators and managers. Detailed training shows the value of the new program and thereby banishes old ideas. A prewet program will require more information for making an informed decision and may involve different methods and materials than do conventional methods.

## 3.3 Prestorm

## 3.3-A Special Considerations

### *Deployment of personnel*

Use of modern weather forecasting information will provide more time in advance of a storm to plan operations. With better information, maintenance teams can more efficiently determine standby status and inform personnel with more lead time. Timely weather information is essential when making effective crew call out decisions.

### *Information assembly*

Several pieces of information need to be assembled upon first notice of a winter storm. The information includes weather forecasts, color weather radar data, and where available, RWIS data. Special attention should be paid to the areas in your vicinity that may have already been affected by the approaching storm. The information can be used to estimate locally when and where the event will begin, its extent, severity, and impact.

### *Decision point*

After reviewing the information, managers must decide when to initiate a treatment and what type of treatment to apply. They make their decision based on a combination of many factors:

- When precipitation is expected to start
- Form of precipitation
- The probable air and pavement temperatures
- The anticipated trend of the temperatures
- The expected sky conditions
- The wind speed and direction
- The intended timing of the treatment
- Traffic considerations and timing

### *Wind*

Experience has shown crosswind speeds in excess of about 12 to 15 MPH may cause drifting across a pavement and retention of snow if the pavement is wet. The threshold wind speed at which this becomes a problem will vary widely with the road site and other conditions. Highway maintenance personnel should be alert to the conditions that may cause interception of snow and incorporate the information in their operations.

### *Safety and handling of liquids*

Liquids stored in unheated tanks could reach temperatures much less than freezing. Therefore, skin contact with the liquid chemicals at these temperatures can result in "instant" frostbite.

Goggles or face shield protection and rubber gloves with long gauntlets should be worn, consult the product's Material Safety Data Sheet (MSDS) for exact handling instructions. All storage and dispensing tanks should be labeled "Liquid prewetting chemical," as well as using the name of the specific liquid. All loading and off-loading should be performed in a safe manner, as close to ground level as possible. Liquids containing chlorides are especially harsh on leather articles of clothing.

## 3.4 During Storm

See Charts in Appendix 4.

## 3.5 After Storm

Careful recording of conditions and the steps taken in response will provide the basis for fine-tuning the program for specific service levels and conditions.

## 3.5-A Assess effectiveness

To improve both the effectiveness and efficiency of a prewet program, the agency should evaluate the performance of its crews and equipment as well as the chemicals. All levels of the agency should be involved in this assessment. Many times, what a supervisor observes during a storm is not readily seen by an operator, and vice versa. Managers should also track the cost and effectiveness of the prewet program, and, if possible, compare the results to conventional snow and ice control operations.

To develop valid results, cost data of a storm or weather event must include all costs for materials (chemicals and abrasives), labor, and equipment employed in operations. For chemicals, this includes the purchase price, transportation to storage site, storage, truck loading, handling and mixing of solid chemicals, and solution preparation. For abrasives it should include both material costs and any clean-up costs. Other costs should be considered, such as the cost of dispatchers, costs of specialized equipment, and cost of patrols.

Agencies should measure the costs and effectiveness of the prewet and conventional operations separately for specific highway sections or routes. Analysts can then calculate the cost per lane mile for each type of operation, and accurately evaluate their relative success. Most importantly, prewet techniques provide the potential for maintaining roads in the best conditions possible during winter storms. Systematic prewet practices might or might not reduce overall costs. Cost savings will depend on the current practice: for example, what LOS governs what materials it uses, whether it is more deicing than anti-icing, and the agency's information sources. Examples of success include providing the same level of maintenance effectiveness at less cost, or providing a higher level of maintenance effectiveness at the same cost. To evaluate the costs or success of anti-icing operations, an agency should examine both costs *and* level of maintenance effectiveness

## 3.6 Post Season

## 3.6-A Evaluate and improve program for next season

Lessons can be learned from both the successes and failures of snow and ice control operations. Prewetting is no exception.  Improvements in operations and equipment can be identified and implemented through post-season assessment of practices and treatments.

Therefore, report anti-icing/ deicing using liquid chemicals for snow and ice control in the daily TAPER log.

The costs and effectiveness of the team section and district's snow and ice control operations can be evaluated based on comparison of the TAPER logs for anti-icing efforts and MDOT's FANCY report for standard snow removal efforts.

Pre-wetting with liquid chemicals is expected to result in improved service to motorists and may translate into a substantial financial savings with regard to materials and time necessary to return the pavement to before-storm conditions.

## 3.6-B TAPER Logs

**T** Temperature of pavement
**A** Application rate
**P** Product (chemical) applied
**E** Event (storm) amount and type of precipitation
**R** Result of snow and ice control activities

## *APPENDIX*

# Appendix 1-Anti-ice/Prewet Resources


1. Publication No. FHWA-RD-95-202, *"Manual of Practice for an Effective Anti-icing Program: A Guide for Highway Winter Maintenance Personnel,"* Federal Highway Administration, Office of Technology Applications, 400 - 7th Street, SW, Washington, D.C. Electronic Version, Posted on the Internet in November 1996: http://www.fhwa.dot.gov/winter/library/libindex.html

2. Blackburn, R., et. al., "Development of Anti-Icing Technology," Strategic Highway Research Program, National Research Council, Washington, D.C., 19943

3. D'Itri, F., Ph.D., *"Chemical Deicers and the Environment,"* Lewis Publishers, Chelsea, Michigan, 1992, Chapter 3.

4. Keep, D. and Parker, D., *"PROACTIVE GUIDE TO SNOW AND ICE CONTROL: A Guide for Highway Winter Maintenance Personnel,"* Ice and Snow Technologies LLC, 2151 Granite Drive, Walla Walla Washington 99362. May 2000.

5. Alger, Adams, and Beckwith, SHRP-H-683, *"Anti-Icing Study: Controlled Chemical Treatments,"* Strategic Highway Research Program, National Research Council, Washington, D.C., 1994.

6. Leggett, Timothy, *"Temperature and Humidity Effects on the Coefficient of Friction Value after Application of Liquid Anti-icing Chemicals,"* Forensic Dynamics, Inc., Kamloops, B.C., 1999.

7. Croteau, J., *"Summary of Evaluation Findings for the Testing of Ice Ban,"* Highway Innovative Technology Evaluation Center (HITEC), Civil Engineering Research Foundation (CERF) Report #40410, American Society of Civil Engineers (ASCE), Washington, D.C., September 1999. pp. 23-25.

8. Blackburn, R., *"Economic Evaluation of Ice and Frost on Bridge Decks,"* Report 182**,** National Cooperative Highway Research Program, Transportation Research Board, National Research Council, 2101 Constitution Avenue N.W., Washington D.C., 1979.

9. S. Edward Boselly**, *"***Benefit/Cost Study of RWIS and Anti-icing Technologies FINAL REPORT***,"*** National Cooperative Highway Research Program, Transportation Research Board, National Research Council, Report 20-7(117)**,** Washington D.C., March 2001.

# Appendix 2-Sample TAPER Log

ROUTE_______

Start of Storm (Time & Date)____________ End of Storm (Time & Date)______________

Storm Totals: Gallons ___________ Tons Salt ___________ Tons Prewetted Salt _________

| TA<br>Time | T (°F) | | A<br>Application Rate | P<br>Product Used | E<br>Event | R<br>Results | Alternative Notes |
|---|---|---|---|---|---|---|---|
| | Air | Pav | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
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| | | | | | | | |

**Note:** See reverse side for code designations

**COLUMN CODES**
Ta = Time of Application
T = Low Temp Since Last Application
A = Application Rate-Gallons/Tons
P = Product Used
E = Event
R = Results

**APPLICATION RATE**
Salt - lbs/lane mile
Prewetted Salt - lbs/lane mile
Liquid Salt - gallons/lane mile

Note time any time the application rate changes.

**TEMPERATURE**
List both pavement and air temperature at the time of notation.

**RESULTS**
1 = Bare
2 = Bare and Wet
3 = Wet with some Tracking
4 = Partial Snow Cover, (Includes Slush) - No Bond
5 = Ice or Compact Snow and Ice- Bonded

Note time any time the event type changes.

**TIME OF APPLICATION**
Note time:
At beginning of application; At the beginning of storm; If there is a change in application rate or product used; If there is a significant change in the storm; At least every 3 hours; At end of storm; When the pavement has returned to a 2 rating; When the pavement has returned to a 1 rating.

**PRODUCT USED**
Salt - S
Prewetted Salt - P
Liquid Salt - L

Note time any time the product used changes.

**EVENT**

| | |
|---|---|
| Light Snow Storm | LS |
| Light Snow with Periods of Moderate or Heavy Snows | IS |
| Weather Event - Moderate or Heavy Snow Storm | HS |
| Weather Event - Frost or Black Ice | BI |
| Weather Event - Freezing Rain Storm | FR |
| Weather Event - Sleet Storm | SS |

Place the event designation in the box and then what has happened since the previous notation.
Note time any time the event type changes.

## Appendix 3-MDOT Salt Gradation

**<u>Gradation:</u>**

Sieve Size

| | | |
|---|---|---|
| 1/2 inch | ………………………………………………………. | 100% |
| 3/8 inch | ………………………………………………………. | 95-100% |
| No. 4 | ………………………………………………………. | 82% Max |
| No. 8 | ………………………………………………………. | 50% Max |
| No. 30 | ………………………………………………………. | 10% Max |

Material passing the No. 30 sieve in excess of 10% will be deducted from the delivered weight of the salt.