HANDBOOK

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Minnesota Snow and Ice Control

Field Handbook for Snowplow Operators

University of Minnesota
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Minnesota Local Road Research Board

Minnesota Snow and Ice Control

Field Handbook for Snowplow Operators

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Mn/DOT Office of Maintenance

Mn/DOT Research Services Section
MS 330, 395 John Ireland Blvd.
St. Paul, Minnesota 55155
Phone: 651-282-2274
Fax: 651-297-2354
E-mail: research@dot.state.mn.us

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This field handbook is dedicated to the plow operators who keep our roads safe all winter long. It is based on the *Manual of Practice for an Effective Anti-icing Program,* produced by the Utah LTAP Center.

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Technical Advisory Panel:
A Technical Advisory Panel was convened to provide input and review drafts of this handbook.

Technical and project leaders:
Wendy Frederickson, Mn/DOT Statewide Winter Maintenance Coordinator
Jim Grothaus, MN LTAP
Kathleen Schaefer, CTAP

Committee members:
Tom Broadbent, Envirotech Services, Inc.
Jeff Dubay, City of Minnetonka
Bernie Fasnacht, City of Mankato
Greg Felt, Scott County
James Klessig, Mn/DOT Central Office
Dave Redig, Mn/DOT District 6, Rochester
Tim Sheehy, Mn/DOT District 1, Virginia
Brian Wolfgram, Mn/DOT District 6, Rochester

Other Contributors: Bob Vasek, Mn/DOT Central Office

Production: Minnesota Local Technical Assistance Program, Center for Transportation Studies (CTS), University of Minnesota
Writing: Connie Fortin and Carolyn Dindorf, Fortin Consulting, Inc.
Editing: Pamela J. Snopl, CTS
Graphic Design: Cadie Wright, CTS

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*Duplicates are provided in the pocket of this handbook for ease of use and photocopying.

Purpose of this Handbook

The purpose of this field handbook is to help promote the understanding of the tools, best practices, and limitations for snow and ice control. The handbook will also help you understand when to use and when not to use these tools and practices. In addition, it encourages progressive changes in snow and ice control practices that will help you reduce salt/sand use and environmental impacts while meeting the safety and mobility needs of roadway users.

Less material on roads means less material in lakes and streams.

Improved practices such as anti-icing, prewetting, and pretreating are emphasized in this field handbook. Also included are standard best practices expected in a quality snow and ice control program.

Throughout the field handbook you will find environmental tips shown with this fish symbol  . These tips are provided to help you reduce environmental impacts from snow and ice control operations.

A blanket approach will not work for the broad range of conditions Minnesota experiences; different strategies are needed for different regions and different conditions. We encourage you to continue to test, document, and refine the practices from this field handbook.

Basic Concepts

Weather

Knowing existing and potential weather conditions is very important for a successful snow and ice control operation. Six pieces of information are especially valuable:

1. Start of precipitation
2. Type of precipitation
3. Total precipitation expected
4. Expected event length
5. Wind conditions (speed, gusts, directions)
6. Temperature trend

Monitor the weather closely so that you are available and prepared to act early in storm situations.

Weather information sources

- Phone 511 to get road condition and travel information or visit the Web: www.511mn.org.
- Talk to neighboring agencies and share information on conditions.
- Subscribe to a value-added meteorological service (VAMS). These are useful for viewing weather forecasts.
- Check the National Weather Service.
- Check all available weather sources.

Pavement temperature

Most weather stations measure temperature and other conditions 30 feet above ground, which means these conditions can differ substantially from pavement temperatures. Thus, use the pavement temperature—not the air temperature—to determine your application rate.

Pavement temperatures can be substantially lower or higher than air temperatures.

You'll notice changes in pavement temperature first on bridge decks; pavement temperatures will also be lower in shady areas.

Measuring with sensors or RWIS

There are two ways to measure pavement temperatures: with sensors or with the Road Weather Information System (RWIS).

Sensors can be hand-held or truck-mounted. Hand-held infrared laser sensors are pointed at the pavement to get a pavement or surface temperature while your vehicle is stopped or moving slowly.

Truck-mounted temperature sensors measure pavement or surface temperatures while your truck is moving. Ideally, every agency should own at least one truck-mounted unit.

RWIS—www.rwis.dot.state.mn.us—is an Internet service provided by Mn/DOT and available to everyone. The RWIS is a predictive system that consists of a network of towers and temperature sensors embedded in state highways.

If you do not have road sensors in your truck, look up the road temperature from the closest state highway on RWIS. This will give you an idea of the local road temperatures.

Dilution: the cause of refreeze

An ice control product will work until product dilution causes the freeze point of the brine to equal the pavement temperature. At this point, the material will stop melting and you may experience refreeze if pavement temperatures are dropping. This process is *Dilution of Solution*.

How long an application will last depends on five factors: pavement temperature, application rate, precipitation, beginning concentration, and chemical type. These factors explain why one application rate will not fit all storm events.

Before the Winter

Take some time before the season to plan your routes and learn the plowing policies. A little planning up-front can help you do a more efficient job in keeping the roads safe.

Policies

- Make sure you have a plowing policy and meet to discuss it. Your level of service may be based on average daily traffic, environmental concerns, safety, mobility, economics, and other factors.
- Inform your citizens of policies.
- Learn to record what and how much you apply on each shift. Be prepared to analyze and make adjustments to your process based on what you learn.

Using less salt doesn't have to reduce safety, but it does protect our lakes.

Plan your routes

- During the fall, inspect and make sure ditches, culverts, and surfaces are free from obstructions and ready for the spring melt.
- Remove potential snow traps, such as tall grasses, that will catch and accumulate snow.
- Drive the assigned routes prior to winter to identify critical areas and find the most efficient way to cover the routes.
- Inventory all the areas prone to drifting and have a plan to manage them.
- Know your routes. Plan which way you will start.
- Be flexible. Conditions could change the way you plow your route.

Calibrate your equipment

All good programs include calibration.

Calibration is an essential procedure to measure the pounds of salt and sand applied to the roadway at various auger settings in relation to truck speed. No matter how sophisticated or simplified your operations, always calibrate yearly.

- Because spreaders vary, calibrate each truck. Re-calibration is required if changes are made to the hydraulic system, if the augers have extensive wear or are resurfaced or replaced, or a different material is used.
- Follow the manufacturer's guidelines for calibration, and contact the manufacturer for training. For manual sander controls, refer to instructions at www.mnltap.umn.edu/publications or see the insert in the pocket of this handbook.

If you don't calibrate your sander, the application rates will not be accurate.

- Calibrate separately for salt/sand mix vs. salt or sand only.
- Remember: The auger plate must be in place during calibration. You are not calibrating the truck properly if the material is gravity-flowing.
- Place the chart in your truck and check it to see how much material will be applied at each setting, or ask your supervisor.

Before the Storm

Anti-icing

Anti-icing is often the most cost-effective and environmentally safe practice in certain winter road maintenance situations. You should consider heading in this direction.

Anti-icing—a proactive approach—should be first in a series of strategies for most winter storms. By applying chemical freezing-point-depressant materials before a storm, you can prevent snow and ice from bonding to the pavement.

Anti-icing requires about ¼ the material of deicing at ⅒ the overall cost, making it the least expensive option for improving traffic safety. Anti-icing is effective and cost-efficient when used correctly and approached with realistic expectations.

Guidelines for anti-icing

- Anti-icing is often effective for heavy frosts.
- Anti-icing works best when combined with accurate road weather information.
- Early application is particularly important for frost or light freezing drizzle.
- Liquids are the most efficient and may be applied days in advance of an event.
- Pretreated salts will work at lower applications (lowest possible setting, less than 100 lbs/two-lane mile) closer to the expected event.
- See the Application Rate Guidelines on page 16 of this field handbook.

Anti-icing can reduce airborne dust and salt particulates.

What to do

- Apply only with stream nozzles to maintain some bare pavement between sprayed areas to reduce slipperiness. Fan spray is not recommended.
- Schedule applications on bridge decks and critical areas if temperature and conditions could produce frost or black ice.
- Consider spot-applications on hills, curves, and intersections if predicted conditions warrant.
- Use appropriate chemical for your pavement temperature range. See the chart on page 19 of this field handbook.

Use wisely. Chlorides can increase the salinity of soil, which can lead to compaction and erosion.

- Apply an anti-ice product during non-rush-hour traffic periods.
- When frost on the shoulder starts to move into the travel lanes, reapply anti-icing product.

What not to do

- Don't anti-ice under blowing conditions, in areas prone to drifting, and anywhere else you would refrain from using salt. Be aware of areas that are prone to wind issues.
- Reapplication isn't always necessary if there is still a residual. The residual effect can remain for up to five days after application if precipitation or traffic wear-off does not dilute the initial application.
- Remember that the surface can refreeze when precipitation or moisture in the air dilutes the chemical.
- Don't apply $MgCl_2$ or $CaCl_2$ to a warm road (above 28° F pavement temperature). It can become slippery and cause crashes!
- Don't apply before predicted rain.
- For the first application or after a prolonged dry spell, apply liquids at half the rate (not half the concentration). On dry roads, liquids tend to mix with oil from vehicles and cause slippery conditions.
- Don't apply too much or the roadway may become slippery. Less is better. Always follow application recommendations.

Equipment

- Anti-icing unit, i.e., transport vehicle with tank.
- Fan spray is not recommended.

Pretreating and prewetting salt and sand

Dry material bounces or blows off the road, so everyone should be either pretreating or prewetting dry material. Liquids also increase salt's effectiveness by jump-starting the melting process. Depending on the liquid used, it can lower salt's effective working temperature.

If you must use dry material, follow best practices to reduce bounce and scatter.

Because pretreating and prewetting cause material to stick to the road, 20 to 30 percent less material is used—saving money and reducing environmental impacts.

Guidelines for pretreating

Pretreating is mixing a liquid into the stockpile of salt or sand before it is applied. Unlike prewetting, it does not require equipment changes and requires no new capital investment for equipment. You can also switch from dry application to wet application immediately—just turn down the application rate.

Chemicals leaching from a stockpile into groundwater is a common problem.

Salt stockpile

- Treat the salt stockpile with a liquid deicing chemical. It may be purchased pretreated or mixed on site by the vendor.
- When treating the stockpile at the shop, apply at 6 to 10 gallons/ton.
- Because leach risk at a stockpile is increased, store it covered on an impervious pad.

Sand stockpile

- Pretreat the stockpile to keep it flowable.
- Apply to stockpile at 4 to 6 gallons of salt brine/ton sand.
- Store the stockpile under cover.

Apply wisely. We will never have a chance to recover the chlorides applied.

Guidelines for prewetting

Prewetting is adding a liquid to the salt as it is being applied—either at the spinner or through a soaker pipe in the auger box—to help it stick to the road better. Although prewetting requires some equipment changes, it provides flexibility to switch the chemical makeup depending on conditions.

- Salt brine, calcium, magnesium chlorides, and acetates may be used as prewetting agents.
- The optimal application rate is 8 to 14 gallons/ton for salt brine.
- Prewetting with other chemicals at the spinner can help reduce the application rate.
- Below 15˚ F, salt brine is less effective than other liquids and may freeze hoses and valves.
- Salt brine should be mixed at 23.3%.

During the Storm

Deicing

Deicing is a reactive operation in which a deicer is applied to the top of an accumulation of snow, ice, or frost that is already bonded to the pavement surface. Deicing generally costs more than anti-icing in materials, time, equipment, and environmental damage.

Use cautiously. Many chemicals contain trace metals including cyanide, arsenic, lead, and mercury.

Removing ice that has already bonded to the pavement can be difficult, and removing it mechanically can damage equipment and roads. Generally, enough ice must be melted chemically to break the bond between the ice and the pavement, which requires larger quantities of chemical than anti-icing.

- Use an appropriate amount of salt. Most oversalting can be prevented by using calibrated, speed-synchronized spreaders and good judgment in selecting application rates and truck speed.
- It is not necessary to melt all the snow or ice on the road with salt. This is an overuse of materials. Apply just enough to loosen the bond between the road and the ice so it can be plowed off.
- See the Application Rate Guidelines on pages 17–18 of this handbook.
- Dilution of Solution (see page 2) also applies to deicing.

The goal is not to melt everything. The goal is to penetrate through the ice and snow and break the bond so the pavement can be plowed.

Winter abrasives use has been documented as an air pollution concern.

Using abrasives

Use winter sand and other abrasives when temperatures are too cold for deicing chemicals to be effective. But be aware that sand does not melt anything. It provides temporary traction, and only when it is on top. Sand also clogs sewers, ditches, and streams. As a result, avoid sand use as much as possible.

A salt/sand mix is generally not recommended. Salt reduces the effectiveness of sand, and sand reduces the effectiveness of salt. However, a salt/sand mix may be helpful in limited situations such as a long freezing rain event where the salt is washed away quickly. A 25 to 50 percent sand/salt mix has been documented as effective in increasing friction by sticking the sand to the surface, like sandpaper.

- Use abrasives in slow-moving traffic areas such as intersections and curves.
- If your purpose is melting, use salt only.
- Salt is ineffective in cold weather, so use sand or an alternative chemical.
- Sand is not cheap when you consider the handling, clean-up, and disposal costs.
- Sweep up sand frequently, after each event if feasible.

If you use a 50/50 salt/sand mix, you're generally either half right or half wrong. Using a salt/sand mix leads to overapplication of both materials.

Standard practices

- Know the pavement temperatures and trends to help you use the right application at the right time. Generally use less chemical when temperatures are rising and more when they are falling.
- Don't apply dry salt (sodium chloride) at below 20˚ F pavement temperature. It will not melt fast enough to help and it will blow off the road into the ditch.
- Below 20˚ F, switch to other tools like $CaCl_2$ and $MgCl_2$ at curves, hills, and intersections to obtain maximum melting. If unavailable, use sand for traction.
- Adjust your spinner speed to the lowest setting possible, except at intersections.
- Drive at the slowest possible speed—17 to 25 mph—slightly higher if prewetting.
- Don't let the traffic dictate your speed. Keep it slow to keep material on the road.
- Apply deicers in the center of the road or high side of the curve.

Sand that washes into a stream or lake may smother some small aquatic organisms.

- Set spinners lower to the ground to reduce bounce and scatter.
- Turn off auger when stopped, even briefly.

Never use calcium chloride to open drains—it is extremely toxic to aquatic systems.

Loading/hauling

- Set up and load on a level surface wherever possible.
- Maintain loading area. Keep it clear and smooth.
- Don't overload. Avoid spilling on units.
- Remove loose material from the exterior of the dump body.
- Watch for co-workers/pedestrians in or near the loading area.

Effective use of plows

Plow to remove snow and loose ice before deicing applications. If snow accumulates before or after applications, plowing directly before your next application will minimize product dilution.

When slush begins to stiffen and kicks to the rear from vehicle tires, it's time to plow and then reapply chemical.

- Plow first before applying deicers to avoid dilution of the salt.
- Coordinate plowing activities to eliminate windrows at intersections and prevent plowing off another operator's material.
- Never plow or blow snow over a bridge into the water or onto traffic below.
- Remove snow from roads as quickly as possible to reduce compaction; use of underbody blades helps remove compacted or slushy snow.
- Make use of carbide plow blade edges.
- Adjust blade angle to maximize cutting efficiency or snow throwing capabilities.

Public safety/operator safety

- Perform your required CDL pre- and post-trip inspections.
- Make sure you're mentally and physically prepared to drive.
- Obey traffic laws. Use the seat belt. Clean lights and windows frequently.
- Flow with traffic as much as possible. Avoid sudden moves. Be alert to all surroundings.
- Demonstrate courtesy toward other drivers and pedestrians.

Once chlorides enter the ground or surface water, they never go away.

Make sure a shield is in place to control the application or you'll overapply salt.

- Be aware of spinner discharge at all times.
- Avoid pushing snow over bridge rails and onto roads below.
- Be alert to hazards such as downed power poles, stop lights, overhead structures, power lines, etc.
- Know the height of your truck box. Raise box only to move material to the back of the box. When raising the box, be certain no overhead obstacles are present.
- Be aware of changing braking abilities from a loaded box to an empty one.
- Keep others informed of changing conditions.
- Assist/report stranded motorists as necessary.

Snow cloud

Be aware of wind conditions and potential problems. Snow clouds can form during any plowing operation. A very slight snow cloud can temporarily block out any lighting configuration and increase chances of being hit from the rear.

- Reduce your speed to minimize snow clouds.
- Don't plow just to plow. If plowing (shoulder) isn't necessary when the wind is blowing, don't do it.

After the Storm

After the storm, when snow and ice control operations have ended, evaluate what was done, how well it worked, and what could be changed to improve operations.

- Accurately record your material use at the end of your shift (see below).
- Attend a post-storm meeting in the shop to evaluate your operations.
- Look for opportunities to try new and improved practices.
- Clean and check all equipment.
- Report any hazards such as low-hanging branches, raised utilities, snow accumulation on bridges, or other potential problems.
- At the end of the season, clean and maintain the truck, tanks, brine-making systems, and pumps according to manufacturer specifications.
- Place all piles on an impervious pad and cover them. This includes salt and salt/sand mixes.

Standard practices

Documenting and charting

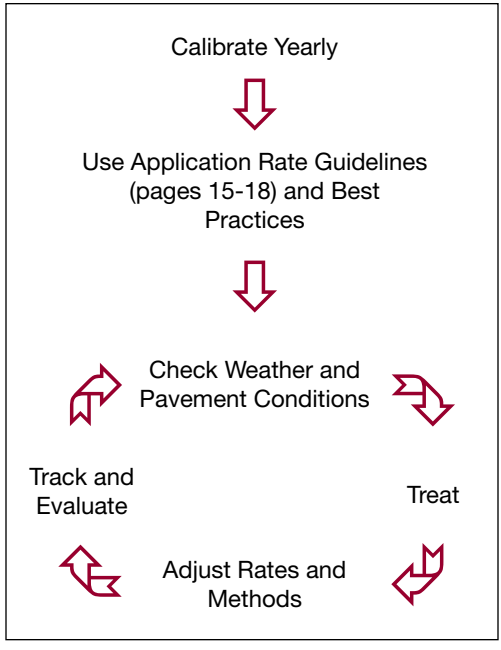
Good documentation helps you use less material, reduce costs and environmental impacts, and run a more effective snow and ice control program. Unless you document and chart, you can't measure what you are doing.

- Track your material use.
- Understand the storm conditions and the target level of service for each route.
- Refine your procedures and material use based on observations.
- Share observations to improve operations and learn from each other.
- Use forms like those shown in the appendix of this field handbook to record and track your work and observations.
- Complete forms at the end of your shift.
- Turn in documentation forms to your supervisor.

You can't manage what you don't measure.

Some fish species are affected by impaired water, which is equivalent to about 1 to 1.5 tablespoons of salt in 5 gallons of water.

Fine-tuning your program



Application Rate Guidelines

Develop your own application rates using the guidelines on pages 16–18 as a starting point and modify them incrementally over time to fit your needs. You can summarize information gathered from your truck logs into application rates for your area. Be aware, though, that sample rate charts vary greatly from one area to another, and most are very high. Make it a goal to reduce application rates while keeping our roads safe. You can reduce rates by following anti-icing and other strategies covered in this field handbook.

Salt spray damages roadside vegetation.

Guidelines for determining application rates

- Sand/salt mix isn't advised but may help in some situations such as freezing rain.
- Always plow before applying chemical. For reapplication, start with the lowest rate in the range.
- High traffic volume will work salt into the snow and aid in melting—so use a lower rate.
- Higher traffic speeds will blow salt off the road and hinder melting—so increase use of prewetted materials.
- Use sand for short-term traction only. It will never melt anything.
- For application on a single lane, cut rates in half. For an 18-foot-wide road, use ¾ of the listed rate (i.e., multiply rate by 0.75).
- It is usually not cost-efficient to apply salt (sodium chloride) at pavement temperatures below 15˚ F.

Anti-icing Application Rate Guidelines

These guidelines are a starting point. Reduce or increase rates incrementally based on your experience.

Condition	Gallons/Lane Mile		Other Products
	$MgCl_2$	Salt Brine	
1. Regularly scheduled applications	15 – 25	20 – 40	Follow manufacturers' recommendations.
2. Prior to frost or black ice event	15 – 25	20 – 40	
3. Prior to light or moderate snow	15 – 25	20 – 50	

Pounds of Ice Melted Per Pound of Salt

Pavement Temp. ˚F	One Pound of Salt (NaCl) melts	Melt Times
30	46.3 lbs of ice	5 min.
25	14.4 lbs of ice	10 min.
20	8.6 lbs of ice	20 min.
15	6.3 lbs of ice	1 hour
10	4.9 lbs of ice	Dry salt is ineffective and will blow away before it melts anything.
5	4.1 lbs of ice	
0	3.7 lbs of ice	
-6	3.2 lbs of ice	

It is not cost-efficient to apply salt (sodium chloride) at pavement temperatures less than 15˚ F.

Deicing Application Rate Guidelines

24' of pavement (typical two-lane road)

These rates are not fixed values, but rather the middle of a range to be selected and adjusted by an agency according to its local conditions and experience.

			Lbs/ two-lane mile			
Pavement Temp. (˚F) and Trend (↑↓)	Weather Condition	Maintenance Actions	Salt Prewetted/ Pretreated With Salt Brine	Salt Prewetted/ Pretreated With Other Blends	Dry Salt*	Winter Sand (abrasives)
>30° ↑	Snow	Plow, treat intersections only	80	70	100*	Not recommended
	Frz. rain	Apply chemical	80 – 160	70 – 140	100 – 200*	Not recommended
30° ↓	Snow	Plow & apply chemical	80 – 160	70 – 140	100 – 200*	Not recommended
	Frz. rain	Apply chemical	150 – 200	130 – 180	180 – 240*	Not recommended
25 - 30° ↑	Snow	Plow & apply chemical	120 – 160	100 – 140	150 – 200*	Not recommended
	Frz. rain	Apply chemical	150 – 200	130 – 180	180 – 240*	Not recommended
25 - 30° ↓	Snow	Plow & apply chemical	120 – 160	100 – 140	150 – 200*	Not recommended
	Frz. rain	Apply chemical	160 – 240	140 – 210	200 – 300*	400
20 - 25° ↑	Snow or frz. rain	Plow & apply chemical	160 – 240	140 – 210	200 – 300*	400
20 - 25° ↓	Snow	Plow & apply chemical	200 – 280	175 – 250	250 – 350*	Not recommended
	Frz. rain	Apply chemical	240 – 320	210 – 280	300 – 400*	400
15 - 20° ↑	Snow	Plow & apply chemical	200 – 280	175 – 250	250 – 350*	Not recommended
	Frz. rain	Apply chemical	240 – 320	210 – 280	300 – 400*	400
15 - 20° ↓	Snow or Frz. rain	Plow & apply chemical	240 – 320	210 – 280	300 – 400*	500 for frz. rain
0 to 15° ↑↓	Snow	Plow, treat with blends, sand hazardous areas	Not recommended	300 – 400	Not recommended	500 – 750 spot treat as needed
< 0°	Snow	Plow, treat with blends, sand hazardous areas	Not recommended	400 – 600**	Not recommended	500 – 750 spot treat as needed

*Dry salt is not recommended. It is likely to blow off the road before it melts ice.

**A blend of 6 – 8 gal/ton $MgCl_2$ or $CaCl_2$ added to NaCl can melt ice as low as -10˚.

How to use the table on page 17:

1. Select the row with the appropriate pavement temperature, temperature trend, and weather conditions.
2. Select the column that has the type of material you are using.
3. Find the box where the row and columns intersect to find the application rate. These rates are not fixed values, but rather the middle of a range to be selected and adjusted by your agency according to your local conditions and experience.
4. Compare those values to the calibration chart for your truck.
5. Dial the correct setting for the rate indicated on the Application Rate Guidelines.
6. If you are not treating a 24-foot-wide road (typical two-lane road), adjust the rate as follows: for application on a single lane, cut rates in half. For an 18-foot-wide road, use ¾ of the listed rate (i.e., multiply rate by 0.75).

Materials and Quality Control

Chemical Melting Temperatures

Multiple products can be used in a snow and ice control program. This chart helps you choose the correct product and apply it at the correct times.

Chemical	Lowest Practical Melting Temperature	Concentration
*NaCl (Sodium Chloride)—Delivered as solid rock salt; also can be made into a brine. The basis of most deicing materials. Very corrosive. Inexpensive.	15˚ F	23.3%
*$MgCl_2$ (Magnesium Chloride)—Delivered as flakes, pellets, or liquid. Often used to wet NaCl crystals to increase adherence to road and reduce melting points. Corrosive. Higher cost.	-10˚ F	27 to 30%
*$CaCl_2$ (Calcium Chloride)—Delivered as flakes, pellets, or liquid. Powerful deicer but extremely corrosive. Sometimes used incorrectly to open storm drains. Higher cost.	-20˚ F	30%
CMA (Calcium Magnesium Acetate)—Delivered as a powder, crystals, pellets, or liquid. Liquid CMA is used mainly on automated bridge deicing systems. Non-corrosive, biodegradable. Sometimes added to sodium chloride as a corrosion inhibitor. Alternative for areas where chloride use must be limited. Higher cost.	20˚ F	32%
KAc (Potassium Acetate)—Delivered as a liquid. Used on automated bridge deicing systems. Use for anti-icing, deicing, and prewetting. Non-corrosive, biodegradable. Alternative for areas where chloride use must be limited. Higher cost.	-15˚ F	50%
Winter Sand/Abrasives—Winter sand is sand treated with brine or another blend. It is often used as an abrasive for low-temperature conditions when chemicals are not effective. Sand provides temporary traction and only works when it is on top of the ice.	Never melts—traction only	

*Liquid chlorides are available with corrosion inhibitors.

Material Conversions

The following quick reference table and the formulas below will help you convert between tons and cubic yards. Weights will vary depending upon moisture content.

Sand		Salt	
Yards	Tons	Yards	Tons
1	1.4	1	1.1
2	2.8	2	2.2
3	4.2	3	3.2
4	5.6	4	4.3
5	7.0	5	5.4
6	8.4	6	6.5
7	9.8	7	7.6
8	11.2	8	8.6
9	12.6	9	9.7
10	14.0	10	10.8
11	15.4	11	11.9
12	16.8	12	13.0
13	18.2	13	14.0
14	19.6	14	15.1
15	21.0	15	16.2
16	22.4	16	17.3
17	23.8	17	18.4
18	25.2	18	19.4
19	26.6	19	20.5
20	28.0	20	21.6

1. To convert tons of clean sand to cubic yards:
   #tons divided by 1.4 = cubic yards
2. To convert cubic yards of clean sand to tons:
   #cubic yards multiplied by 1.4 = tons
3. To convert tons of winter sand to cubic yards:
   #tons divided by 1.37 = cubic yards
4. To convert cubic yards of winter sand to tons:
   #cubic yards multiplied by 1.37 = tons
5. To convert tons of straight salt to cubic yards:
   #tons divided by 1.08 = cubic yards
6. To convert cubic yards of straight salt to tons:
   #cubic yards multiplied by 1.08 = tons

Materials testing

Test your materials to ensure that they are delivered as ordered and will perform as needed. Refer to your contract or Material Safety Data Sheet (MSDS) for specific gravity.

Testing liquids

- Before unloading the tanker truck, use a clean container to obtain a small sample (about 2 cups).
- Measure the specific gravity or percent saturation using a hydrometer or salimeter.
- Make sure you have the correct hydrometer for your material.
- Salt brine should have a salimeter reading of 85% or a hydrometer reading of 1.176, which equates to 23.3% salt in the brine.
- If the specific gravity is not within specifications, don't unload, and notify your supervisor.

Protect our roadside vegetation. Chlorides can damage vegetation at concentrations greater than 70 ppm (about 1/3 teaspoon of salt in 5 gallons).

Testing sand

- Conduct a visual inspection of the material to make sure it is clean.
- Note that each user has its own specifications based on available materials.

Testing solid salt

- Make sure someone is present to watch the load being dumped and observe if it is wet.
- Test salt for moisture content. You are looking for a moisture content of less than or equal to 1.6%. (Check your agency's specification.)

How to measure the moisture content of rock salt:

- Get your supplies: an accurate scale and ½ cup to 1 cup of salt taken from the pile, away from the outer edge.
- Microwave on high for 1 ½ minutes, stir and repeat.
- Record the information on the worksheet on page 22 and calculate % moisture.

Salt Moisture Worksheet

(with scale zeroed out to account for container)

Date: Company:

P.O. #: Ticket #:

A. Weight of wet salt

B. Weight of dry salt

C. Weight loss (A-B)

Tested by:

Moisture Calculations:

C ÷ A x 100 = % moisture

Remarks:

Use the chart below to evaluate product acceptability
(Example Mn/DOT specification):

Percent Moisture	Recommended Action
0 – 1.6%	Accept load
>1.6 – 2.0%	Deduct 5% from the price
>2.0 – 2.5%	Deduct an additional 3% in contract price for each 0.1% of moisture content in the salt in excess of 2.0% .
>2.5%	Reject the load

Bibliography and Additional Resources

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University of New Hampshire Technology Transfer Center. *Manual of Practice*. www.t2.unh.edu/pubs/manofpractice_1.pdf

Utah LTAP Center. *Manual of Practice for an Effective Anti-icing Program: A Guide for Highway Winter Maintenance*. www.utaht2.usu.edu

Training and technical assistance

- The Circuit Training and Assistance Program (CTAP), a joint program of Mn/DOT and the Minnesota Local Technical Assistance Program (LTAP), brings training to your doorstep. For workshop registration, call 651-282-2160 or visit www.mnltap.umn.edu/ctap.

- Minnesota LTAP offers a series of workshops around the state on a variety of topics. Visit www.mnltap.umn.edu or call 612-626-1077.

- Mn/DOT Winter Maintenance Coordinator: 651-284-3606

Other Web resources

- Iowa Department of Transportation. *Anti-icing Equipment Manual* (with drawings for shop-made equipment). www.dot.state.ia.us/maintenance/manuals/equip/intro.htm

- Minnesota Department of Transportation. *Guide to Field-Testing Deicing and Anti-Icing Chemicals*. www.dot.state.mn.us/maint/research/chemical/chem_evaluation_guide.pdf

- Pacific Northwest Snowfighters.
  www.wsdot.wa.gov/partners/pns/default.htm

- Salt Institute.
  - *Practical Guide for Storing and Handling Deicing Salt*. www.saltinstitute.org/snowfighting
  - Calibration Instructions (with downloadable Excel worksheet) www.saltinstitute.org/snowfighting/6-calib.html
  - Snow and Ice electronic mailing list: www.sicop.net

Appendix

Example Daily Salt/Sand Use Ticket

Operator		Shift		Date		
Truck No.		Capacity				
Weather				Temp.		
Stockpile	Route	Yards Sand	Yards Salt	Yards Used	Yards Returned	Liquid Gallons
TOTALS						

Example Loader Ticket: Daily Salt/Sand Issued

Operator _____ Shift _____ Date _____

Loader No. _____ Capacity of Bucket _____

Stockpile	Truck #	Yards Sand	Yards Salt	Stockpile	Truck #	Yards Sand	Yards Salt
TOTALS							

Example Documentation Form For Anti-Icing

Anti-icing Route Data Form				
Truck Station: Date:				
Air Temp.	Pavement Temp.	Relative Humidity	Dew Point	Sky
Reason for applying: Route: Chemical: Application Time: Application Amount: Observation (1st day): Observation (After event): Observation (Before next application): Name:				

Bare Lanes Data Collection Sheet

Event Began		Event Ended		Event Type	
Date Time		Date Time		(snow, rain, both, drifting)	
Description	Route #	Bare Lanes Lost		Bare Lanes Regained	
		Date	Time	Date	Time

For ease of use and duplication, the following tables and forms are included in this pocket:

- Application Rate Guidelines
- Calibration Procedures
- Salt Moisture Worksheet
- Example Daily Salt/Sand Use Ticket
- Example Loader Ticket
- Example Documentation Form for Anti-icing
- Bare Lanes Data Collection Sheet

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Snow and Ice Control

Calibration Procedures for Spreaders

Four basic steps

1. Measure the amount of sand and salt discharged in one auger revolution.
2. Count the number of auger revolutions per minute at each setting.
3. Determine the discharge rate by multiplying the number of revolutions per minute by the amount of sand and salt discharged per revolution.
4. Multiply the discharge rate by the minutes it takes to travel one mile.

Example:

Speed		Time to travel one mile
20 mph	=	3 minutes

Minutes/mile x Discharge rate/minute = lbs/mile at setting number 4

3 min. /mi. x 200 lbs/min. = 600 lbs/mi.

Step-by-step calibration procedures

1. Move the spinner out of the way and set the spinner control to zero. In most situations it is not necessary to disconnect the hydraulic hose.
2. Set the auger control for a normal operating mode.
3. Clean the shaft end of the auger and place an index mark on it, so you can count the number of auger revolutions.
4. Install an auger shield to gain the most accurate measurement.
5. Place enough sand and salt in the truck to put a load on the spreader. The material used for calibration should be of the same percentage mix as what you normally use on the road.
6. Rev the engine to normal operating speed of at least 1500 RPM.
7. Let the auger discharge for a few revolutions until there is a steady flow of sand and salt.
8. While the material is flowing steadily, the observer tells the collector to hold the pail under the discharge of the spreader.
9. The observer counts aloud the revolutions of the auger. When the pail is two-thirds full, the observer gives a verbal signal and the collector removes the pail.
10. The observer records the number of auger revolutions on the Calibration Worksheet Field Collection Chart.
11. Weigh the pail containing the sand and salt sample. Remember to deduct the weight of the pail. Record the pounds for this first sample on the Field Collection Chart.
12. Perform steps 9 through 12 two more times, collecting a total of three samples. Record this data on the Field Collection Chart. Calculate the average by adding the three numbers together and then dividing that total by three. Record your calculated average pound per revolution on the Field Collection Chart in the bold box and in column C on the Calibration Worksheet Application Rate Chart.
13. This completes the steps to collect and weigh the three samples.
14. Next, count the number of auger revolutions at each setting of the sander. One person counts the auger revolutions for 15 seconds at every setting while another person times this procedure. Record the results on the Calibration Worksheet, Application Rate Chart Column A. Multiply by 4 to get revolutions per minute (RPM) and record in Column B.
15. Calculate the Discharge Rate by multiplying Column B by the Average Pounds per revolution from Column C (transferred from the Field Collection Chart).
16. Determine the Application Rate (pounds discharged per mile) by multiplying the Discharge Rate (Column D) by the minutes to travel 1 mile at varying speeds as shown in the columns labeled E. Repeat for each control setting.
17. Transfer the numbers from Column E of the Application Rate Chart to the Calibration Cab Card in the truck. Round off all numbers to the nearest 25 pounds.

Calibration Worksheet

Manual spreaders

Spreader Information

Agency		Location	
Date		Calibrated by	

Field Collection Chart

	Pounds		Auger Revolutions		Pounds per Revolution		To determine the average:
Sample #1		?		=		}	Add these 3 numbers (pounds per revolution) and divide by three.
Sample #2		?		=			
Sample #3		?		=			
			Total				
			Average pounds per revolution			Record in column C below	

Application Rate Chart

							Application Rate in pounds per mile				
	A		B		C	D	E				
Control Setting	Auger Revs. /15 Sec	X 4	RPM	X	Average* pounds per revolution	Discharge Rate (lbs/min)	(15 mph) x 4.00**	(20 mph) x 3.00	(25 mph) x 2.40	(30 mph) x 2.00	(35 mph) x 1.71
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											

*This number remains constant and is obtained through the calculation in the field collection chart

**Minutes to Travel One Mile

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Deicing Application Rate Guidelines

24' of pavement (typical two-lane road)

These rates are not fixed values, but rather the middle of a range to be selected and adjusted by an agency according to its local conditions and experience.

			Lbs/ two-lane mile			
Pavement Temp. (ºF) and Trend (↑↓)	Weather Condition	Maintenance Actions	Salt Prewetted/ Pretreated With Salt Brine	Salt Prewetted/ Pretreated With Other Blends	Dry Salt*	Winter Sand (abrasives)
>30° ↑	Snow	Plow, treat intersections only	80	70	100*	Not recommended
	Frz. rain	Apply chemical	80 – 160	70 – 140	100 – 200*	Not recommended
30° ↓	Snow	Plow & apply chemical	80 – 160	70 – 140	100 – 200*	Not recommended
	Frz. rain	Apply chemical	150 – 200	130 – 180	180 – 240*	Not recommended
25 - 30° ↑	Snow	Plow & apply chemical	120 – 160	100 – 140	150 – 200*	Not recommended
	Frz. rain	Apply chemical	150 – 200	130 – 180	180 – 240*	Not recommended
25 - 30° ↓	Snow	Plow & apply chemical	120 – 160	100 – 140	150 – 200*	Not recommended
	Frz. rain	Apply chemical	160 – 240	140 – 210	200 – 300*	400
20 - 25° ↑	Snow or frz. rain	Plow & apply chemical	160 – 240	140 – 210	200 – 300*	400
20 - 25° ↓	Snow	Plow & apply chemical	200 – 280	175 – 250	250 – 350*	Not recommended
	Frz. rain	Apply chemical	240 – 320	210 – 280	300 – 400*	400
15 - 20° ↑	Snow	Plow & apply chemical	200 – 280	175 – 250	250 – 350*	Not recommended
	Frz. rain	Apply chemical	240 – 320	210 – 280	300 – 400*	400
15 - 20° ↓	Snow or Frz. rain	Plow & apply chemical	240 – 320	210 – 280	300 – 400*	500 for frz. rain
0 to 15° ↑↓	Snow	Plow, treat with blends, sand hazardous areas	Not recommended	300 – 400	Not recommended	500 – 750 spot treat as needed
< 0°	Snow	Plow, treat with blends, sand hazardous areas	Not recommended	400 – 600**	Not recommended	500 – 750 spot treat as needed

*Dry salt is not recommended. It is likely to blow off the road before it melts ice.

**A blend of 6 – 8 gal/ton $MgCl_2$ or $CaCl_2$ added to NaCl can melt ice as low as -10°.

Anti-icing Application Rate Guidelines

These guidelines are a starting point. Reduce or increase rates incrementally based on your experience.

Condition	Gallons/Lane Mile		Other Products
	$MgCl_2$	Salt Brine	
1. Regularly scheduled applications	15 – 25	20 – 40	Follow manufacturers' recommendations.
2. Prior to frost or black ice event	15 – 25	20 – 40	
3. Prior to light or moderate snow	15 – 25	20 – 50	

How to use the table on the opposite side of this page:

1. Select the row with the appropriate pavement temperature, temperature trend, and weather conditions.
2. Select the column that has the type of material you are using.
3. Find the box where the row and columns intersect to find the application rate. **These rates are not fixed values, but rather the middle of a range to be selected and adjusted by your agency according to your local conditions and experience.**
4. Compare those values to the calibration chart for your truck.
5. Dial the correct setting for the rate indicated on the Application Rate Guidelines.
6. If you are not treating a 24-foot-wide road (typical two-lane road), adjust the rate as follows: for application on a single lane, cut rates in half. For an 18-foot-wide road, use ¾ of the listed rate (i.e., multiply rate by 0.75).

Salt Moisture Worksheet

(with scale zeroed out to account for container)

Date: Company:

P.O. #: Ticket #:

A. Weight of wet salt

B. Weight of dry salt

C. Weight loss (A-B)

Tested by:

Moisture Calculations:

C ÷ A x 100 = % moisture

Remarks:

Use the chart below to evaluate product acceptability
(Example Mn/DOT specification):

Percent Moisture	Recommended Action
0 – 1.6%	Accept load
>1.6 – 2.0%	Deduct 5% from the price
>2.0 – 2.5%	Deduct an additional 3% in contract price for each 0.1% of moisture content in the salt in excess of 2.0% .
>2.5%	Reject the load

Example Daily Salt/Sand Use Ticket

Operator			Shift		Date	
Truck No.			Capacity			
Weather					Temp.	
Stockpile	Route	Yards Sand	Yards Salt	Yards Used	Yards Returned	Liquid Gallons
TOTALS						

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Example Loader Ticket: Daily Salt/Sand Issued

Operator _____ Shift _____ Date _____

Loader No. _____ Capacity of Bucket _____

Stockpile	Truck #	Yards Sand	Yards Salt	Stockpile	Truck #	Yards Sand	Yards Salt
TOTALS							

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Bare Lanes Data Collection Sheet

Event Began		Event Ended		Event Type	
Date Time		Date Time		(snow, rain, both, drifting)	
Description	Route #	Bare Lanes Lost		Bare Lanes Regained	
		Date	Time	Date	Time

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