



Salt Institute

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THE SNOWFIGHTERS HANDBOOK

40TH YEAR EDITION



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The Snowfighter's Handbook

A Practical Guide for Snow and Ice Control



*Dedicated to the people
who provide safety and mobility
on roads in winter — **the snowfighters***



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FOREWORD

This manual prepared by the Salt Institute is dedicated to the thousands of men and women in public works agencies at all levels whose task is providing safe streets and highways during winter storms.

We commend all those agencies practicing the *Sensible Salting* approach to snow and ice control which emphasizes getting the most from every application of deicing salt while maintaining the safest roads possible in the most economical way and protecting the environment.

Modern strategies to effectively deal with winter road hazards depend upon having the most up-to-date information of expected weather conditions including the Road Weather Information System (RWIS), the timely deployment of anti-icing to prevent ice-pavement bonding, properly calibrated application of road salt, improved equipment, automatic spreader controls, sufficient covered storage and stockpile logistics to make salting of roads the most effective and safest customer-driven method for snow and ice control.

Salt is a necessary and accepted part of our winter environment to assure safety and mobility for the individual motorist, commercial vehicles and, especially, ambulances, fire engines and other emergency equipment. Delays in reaching victims or getting them to hospitals are often the critical differences between life and death.

Beyond providing safety and essential mobility, the modern snowfighter must be accountable for meeting the community's needs as well as the safeguarding our environment.

Environmental problems concerning use and storage of salt need not exist if there is a balanced approach to the use of salt for snow and ice control — one that demonstrates the safety and mobility for people and care for the environment.

Winter maintenance procedures are constantly changing. Current practices will be improved and new techniques perfected. But it is unlikely there will ever be a material as efficient, as inexpensive, as safe or as plentiful as sodium chloride, ordinary salt, for removing ice and snow from roads in winter.

“The Snowfighter’s Handbook” was originally published in 1967. It has been accepted as the authoritative guide for proper salting procedures and techniques. This is the fifth edition of this popular training tool.

The purpose of this manual is to provide the snowfighter with information, including the latest procedures and techniques, for combating winter storms.

The *Sensible Salting* methods contained in this manual are the cornerstones of an effective winter maintenance program which will help snowfighters provide the public with the most effective snow and ice control program possible at the lowest overall cost and least impact on the environment.

Two other very practical Guidebooks, *Highway Salt and Our Environment* ©2004 and *The Salt Storage Handbook* ©2006 are also available from the Salt Institute. ❄



1 HOW IMPORTANT IS THE WINTER MAINTENANCE FUNCTION?

Snow and ice control is often the single largest cost item in the maintenance budget for streets and highways. In a recent year, snow removal in 33 snow belt states accounted for 20-25% of total maintenance costs and almost 5% of all highway expenditures.

For this reason, and because of its impact on public safety and essential mobility, snow and ice control deserves special attention from top highway management as well as from those in maintenance at all levels.

With nearly 300 million motor vehicles registered in the U.S., and more than four million miles of roads and streets, more must be done with the winter maintenance dollar than simply providing traction over ice and snow.

Most Canadian road authorities have an even tougher job than their U.S. counterparts. Canada's commerce and industry depend upon safe transportation and communication throughout the vast nation. Yet, Canadian winters threaten for six months every year, with colder temperatures and more frequent snows than in the United States.

The common standard for snow and ice control on many miles of streets and highways is removal of these substances as soon as possible to provide safe pavement through *Sensible Salting*. Nearly every state, province, city and toll road in the snow belt has some mileage on a clear pavement program. These facts about our motorized economy show why:

- Motorists now travel more than three trillion vehicle miles each year.
- More than 75% of workers who commute drive to work.
- More than 80% of intercity travel is by motor vehicle.
- Suburban growth has drastically increased traffic densities on most street and highway systems.

- Access to retailers, service establishments and other businesses is often wholly dependent on auto or truck transportation.
- Just-in-time manufacturing practices require reliable highway access for economic efficiency and competitiveness in snow belt areas.
- Web-based sales are pushing incredible parcel delivery growth.
- Increasing traffic volumes, the reliance of our society on daily mobility and the urgency of moving emergency vehicles without delay demand efficient snow and ice removal to keep traffic moving all year around.

Sensible Salting provides safe pavement in an environmentally sensitive manner. By preventing the bonding of snow and ice to pavements as soon as possible, snow fighting materials are used most efficiently with minimal loss to the environment. Benefits of this high maintenance standard are apparent:

- Traffic keeps moving.
- Commerce and industry go on at near-normal pace.
- There are fewer accidents, injuries and deaths.
- Minimal environmental impact.
- Emergency vehicles get through.

The public is less tolerant of failure in snow and ice control than in any other highway or street department function. A snowstorm affects the entire community — often entire states. Unless a storm is handled capably by maintenance forces, it can upset considerably the daily routines of individuals, adversely affect business and commerce, and endanger public safety. ❄



2 TRAIN FOR TEAMWORK

Maintenance people typically feel a keen obligation to the traveling public. They have a kind of esprit de corps that comes only with training and experience.

Proper training for maintenance personnel is vital. It provides the know-how to get the job done and encouragement to perform in a way that brings praise rather than discredit to your organization.

Many maintenance organizations conduct training courses in the early fall months to assure that:

- Equipment operators fully understand how to operate and maintain plows, spreaders, loaders and other equipment used for winter maintenance.
- All employees are thoroughly familiar with their responsibilities.
- All employees receive a full review of snow removal schedules, snow routes and personnel and equipment assignments.
- Dry-runs are made over areas to be covered during actual snowfighting operations.
- All employees understand how salt works in snow and ice so they know how, when and in what amounts it should be applied.

The underlying theme of all training sessions should be the *Sensible Salting* concept, which includes:

- Proper covered storage
- Good maintenance of storage areas
- Good equipment maintenance and knowledge of equipment
- Proper spreader calibration
- Proper salt application
- Concern for our environment as well as the public's safety

Every agency should have a fall meeting.

A session on snow and ice removal well ahead of winter gives a chance to discuss your plans with the people expected to carry them out. This meeting is a refresher course on snowfighting tactics for experienced employees and an introduction to winter maintenance for new personnel.

This meeting gives management a chance for a formal review of the previous winter's operation with operators and supervising personnel. Use it to determine what may have gone wrong last winter, and then make corrections for the coming season.

Promote a free exchange of ideas at the fall meeting. Encourage all personnel to speak up. New ideas and better tactics can come out of this session. ❄️

Suggested Program Outline For Fall Training Sessions

I. The Importance of Coordination

- Know Your Plowing and Spreading Routes
- Effective Radio Communication
- The Storm Warning System
- Working with Police, Other Public Agencies and the Media

II. Equipment — Its Operation and Maintenance

- Plows
- Spreaders, Sprayers and Their Controls
- Loaders
- Emergency Repair and Refueling Stations
- The Importance of Preventive Maintenance

III. Application Procedures

- How Salt Works
- How and When to Salt
- Anti-Icing vs Deicing
- Application Rates
- Special Storm Conditions
- Special Deicing Problems (Bridges, Elevated Curves, Ramps, Intersections)
- When to Re-Apply Salt

IV. Review of Winter Maintenance Policy

- Snow Emergency Routes
- Parking Ordinances
- Procedures for Helping Motorists
- Importance of Personal Public Relations by Maintenance Personnel

V. On-the-job Safety

- Safety Equipment
- Safety Practices

VI. Discussion, Questions and Answers

To assure yourself that your department is ready for winter, you might have superintendents or foremen complete a check list showing their progress in pre-winter preparations. A suggested check list similar to that used by a number of cities and states, is illustrated on pages 22 and 23.

3 MAKING EQUIPMENT COUNT

Equipment can make or break a maintenance organization. It must be suited to the job — and it's a tough job! Winter operations require the highest level of equipment maintenance.

It is a good idea to review equipment needs immediately after each winter season, when they are fresh in your mind. If new equipment is required, it can be ordered with good assurance of delivery prior to the next winter season.

A secret to successful winter maintenance is the ability to fight storms with equipment already on hand. The key is proper equipment maintenance. Snow and ice control equipment should never be stored without being cleaned. It should be inspected for possible repairs, and repaired if necessary.

In Fall training sessions, discuss each type and class of equipment which employees will operate. Go over strengths and weaknesses of each. Describe performance capabilities, load and weight limits, specifications, safety considerations, attachments and modifications.

If possible, assign each operator to a specific spreader, plow or loader. Man and machine make a better team when they work together regularly. The feeling that a vehicle "belongs" to an employee also will make an operator show more responsibility for its upkeep.

In some organizations, it may be necessary to switch operators from one piece of equipment to another. Then management must depend on a system of checks to ensure that equipment is properly operated and maintained.

Thoroughly inspect all equipment during late summer or early fall. Make all repairs and order stocks of parts not locally available. Pay particular attention to these components:

- Inspect condition of moldboard and cutting edge of all snowplows. Order adequate stocks of parts for all types of plows.
- Inspect snowplow hoists and under-body blades. Check air and hydraulic hoses and other critical parts of power units and obtain adequate replacement stocks.

- Mount, load and test all spreaders and sprayers. Make necessary repairs and order critical parts. Calibrate all spreaders and place the calibration card on a visor or in the glove compartment of the truck. Supervisors should have copies of all calibration cards on file.
- Inspect all vehicle lighting, including wiring and sockets on headlights, tail lights, stop lights and turn signals. (Warning lights must be visible from all sides, whether bodies are raised or lowered.)
- Make sure sufficient stocks of tire chains, tires, spreader repair parts and other miscellaneous supplies are on hand.
- Make sure all personnel are familiar with spreader/sprayer controls, whether manual or automatic.

To keep equipment in top condition, establish a regular maintenance routine to be followed all winter. Equipment operators should inspect vehicles after each storm and report needed repairs to the garage or to the staff mechanic. Spreaders will need to be recalibrated after repair to the hydraulic system.

The first step in vehicle maintenance is to make sure every operator knows what to expect of each piece of equipment. Operators should check these items carefully.

Spreaders/Sprayers — Inspect pumps, hoses, controls, and fittings. Check spinners, augers, and auxiliary engines.

Controls — The two major components of any hydraulic system are the pump and the controls, whether manual or automatic. All operators should become thoroughly familiar with spreader controls. No two hydraulic systems are exactly the same. Therefore, controls may differ from truck to truck. Know your equipment and how the auger or conveyor and the spinner react at various settings.

Plows — Carefully inspect blades after each use. If blade wear begins eating into the moldboard, it will be very costly to replace. Remember that snow plow blades do not wear evenly. Replace blades when they are badly worn at any point! Have operators check blade wear during storms.



(Right-hand plows wear most rapidly on the left side, while the opposite is true for left-hand plows. Reversible plows may show wear on either side, depending upon operating time in each position.)

All Electrical Equipment — Inspect and service all lighting and electrical equipment regularly, including wiring and sockets. Carry ample stocks of parts for rotating flasher units, including lenses and lamps. Faulty wiring and failure of alternators, generators and batteries cause the most downtime in winter maintenance vehicles. Nothing is more terrifying and dangerous than a stalled and darkened vehicle in a winter storm.

Safety Equipment — Make sure there are flashlights, flares, flags and safety vests in truck cabs. A first aid kit is also a good idea. It is preferable to wear hardhats at all times and don't start out without securing seat belts.

All vehicle operators should know the location and telephone numbers of emergency repair and refueling stations. Qualified personnel should be on hand in garages during storms to carry out minor repairs promptly or make a start on major repairs. **Replenish spare parts inventories immediately following storms.**

Equipment needs vary markedly. How many plows, spreaders or sprayers are necessary for each mile of pavement depends upon snowfall, frequency of storms, traffic and topography. How much equipment an agency can afford is an important consideration as well. A straight salt program requires less equipment than one using abrasives, or alternative deicers.

Despite careful planning, equipment on hand may be inadequate in certain situations. *Don't be caught short!* Compile a list of all rental equipment available from contractors or haulers during snow emergencies. List specifications, rental rates and the names, addresses and telephone numbers of owners.



Establish ground rules for contracting for this equipment. It is important that every supervisor understands who has the authority to call rental equipment into action.

Arrange before winter to borrow equipment and operators in emergencies from local military installations, reserve units or neighboring maintenance agencies. Determine which officer is responsible for specific equipment and negotiate details for its use, if it is needed. It is difficult to know when a blizzard will strike, requiring tracked vehicles or other heavy equipment. Training sessions should include operators who may be brought in during emergencies, whether contract operators and/or equipment. They should also include other departments such as sewer and water or the park service. In fact, anyone capable of driving a plow and/or spreader should be trained and included whenever possible.

Warning! Before permitting rented or loaned equipment to operate, make sure your department is protected from liability for property damage or injuries resulting from accidents, and that insurance coverage is adequate and complies with all state and local laws or ordinances.

Preventive maintenance is crucial! After each storm, all equipment must be cleaned, washed and allowed to dry. When dry, components such as chains, sprockets, hinges, spinners and other moving parts should be coated with used motor oil, diesel fuel or kerosene. Grease all bearings. Check hydraulics and quick disconnects for leakage. All washing and maintenance must be conducted in specific areas to protect the equipment and to allow capture and treatment/recycling of washwater.

The versatile underbody plow is very valuable in snowfighting. In light snow, it can run at fairly high speeds with safety. It can usually be purchased economically. The underbody blade is also a good training tool for new operators. ❄️

4 OTHER PRE-WINTER PLANNING

All major arteries and feeders, including interstates, primary and secondary roads should be included in an agency's *Sensible Salting* program. Primary routes should have higher priority than secondary roads.

Only someone thoroughly familiar with a given locality can assign levels of maintenance and schedule performance of the work for optimum results. Local traffic patterns, traffic volume, the needs of local industry and business and special problems created by topography or climate must be considered.

However, here are a few guidelines for determining required levels of maintenance:

- Many agencies determine maintenance levels based on average daily traffic (ADT)
- Give priority to important local arterials, including school bus routes, access roads to industrial parks or major plants, mail delivery routes and streets leading to hospitals, fire stations and maintenance garages.
- Provide safe pavement on all truck routes that carry heavy vehicles around a city or through selected sections. Remember that these routes require around the clock attention.
- Carry levels of maintenance to logical stopping points, such as traffic signals, intersections or slow speed zones. This priority gives motorists time to adjust to the shift in maintenance levels.
- Make sure maintenance sections link or overlap. Leaving a gap between sections on a high-speed roadway can present potentially hazardous conditions.



Interstate and expressway routes that pass through or near cities carry increased traffic volumes onto city arterials. Ramps and other approaches to major city routes need special attention. A bare street or road is worthless unless traffic can get on and off. Plow and salt ramps of major arterials early in storm.

After thorough planning has been done, post a master-map showing routes, snowplowing and salting schedules and equipment and operator assignments. For added control, give each driver an individual map of his route or area. Be sure to update maps each year to show new roads, interchanges, streets, bridges and governmental boundary lines.

For top efficiency in scheduling operations, aim for maximum equipment and manpower utilization. Try setting up salt routes that bring spreaders back to storage sites as

they empty. It may be desirable to stockpile salt at several locations so spreaders won't waste time deadheading.

Spreading rates differ based on types of storm, weather conditions and operational procedures. Application rates generally range from 300 to 800 lb per two-lane mile. **For convenience in estimating your season needs, the following chart is based on four 500 lb applications per storm.**

Mark the spots that won't be there.

Before winter, mark all structures, such as drop inlets, catch basins, ends of curbing and guardrail and fire hydrants. Once covered with snow, they will be difficult or impossible to see from a plowing or spreading vehicle. Use special markers to pinpoint locations of drains and waterways that must be opened after each storm.

Where does snow fencing go? Only practical experience and analysis can tell where to erect snow fencing. Where it is placed depends entirely upon topography, prevailing winds and existing vegetation. Fencing should never be erected nearer than 75 to 100 ft from the centerline. It always is placed on the side of the roadway from which prevailing winter winds blow and should be perpendicular to wind direction, not necessarily parallel to the road. Positioning of snow fencing may be changed from one year to the next. Slopes, grading and tree growth often alter placement.

Notify property owners. Remember to contact property owners before erecting snow fence outside rights-of-way. In long fence sections, leave an occasional gap so livestock can go through. It is good community relations and will prevent damage to fencing as well. ❄

Tons of Salt Required Per Season (Based on 4 applications of 500 lb per 2-lane mile per storm)							
No. of Storms	Miles of Two-lane Highway on Clear Pavement Standard						
	100	200	300	400	500	600	700
4	400	800	1200	1600	2000	2400	2800
6	600	1200	1800	2400	3000	3600	4200
8	800	1600	2400	3200	4000	4800	5600
10	1000	2000	3000	4000	5000	6000	7000
12	1200	2400	3600	4800	6000	7200	8400
14	1400	2800	4200	5600	7000	8400	9200
16	1600	3200	4800	6400	8000	9600	10,200
18	1800	3600	5400	7200	9000	10,800	11,600
20	2000	4000	6000	8000	10,000	12,000	14,000

*Note: Minimum storage requirement is usually half of annual salt use.
This chart is computed on the basis of one ton of salt per two-lane mile per storm, or four 500 lb applications per storm.
Note: These are average figures. Conditions in some areas require several times the salt needed in some other areas.*

5 KNOW DIFFERENT TYPES OF SNOW

In spots where unusual drifting is expected, place one or more rows of fence, with the second line parallel to and about 50 ft from the first.

What about “self-help” barrels? Many public works agencies place “self-help” salt barrels at critical points where motorists are likely to have tough going during winter.

Eliminate runoff from stored salt.

Improper stockpiling of salt is responsible for as much as 80% of environmental problems associated with salt use. Rain and melting snow can carry salt from uncovered piles into the ground and nearby bodies of water and possibly cause chloride build-up.

Salt piles **must** be covered on an impermeable pad. Salt users usually prefer permanent structures on asphalt pads with proper drainage. Temporary waterproof coverings can be effective if tended carefully. Covering salt also helps avoid loss of material through leaching and caking. Also, salt without cakes and lumps spreads with no difficulty.

Snow occurs when water vapor in an air mass is cooled below freezing. Density of snow varies greatly. Some storms produce wet snow like wet sand, others dry snow like sawdust. Wet or heavy snow can often be plowed away. Time is of the essence. Use of reliable weather forecasting services allows for crew readiness in advance of storms. Salt should be applied as soon as snow or ice begins to accumulate.

Winter storms produce a number of hazardous conditions other than snow. Even without rain, ice may occur when moist air contacts a cold surface, particularly on bridge decks. Rain may freeze as it falls on pavement. Frozen rain falls as sleet or hail; it may stick to pavements.

There are roughly five major kinds of storms, as shown in the “Stormfighting Guidelines” box. Each requires a somewhat different approach. Everyone on the maintenance force should know these basic kinds of storms and how to combat them.

Stormfighting Guidelines	
The following chart is a guideline to combat various types of storms. Local conditions and policies will be the final determining factor.	
Condition 1 Temperature Near 30 Precipitation Snow, sleet or freezing rain Road Surface Wet	If snow or sleet, apply salt at 500 lb per two-lane mile. If snow or sleet continues and accumulates, plow and salt simultaneously. If freezing rain, apply salt at 200 lb per two-lane mile. If rain continues to freeze, re-apply salt at 200 lb per two-lane mile. Consider anti-icing procedures.
Condition 2 Temperature Below 30 or falling Precipitation Snow, sleet or freezing rain Road Surface Wet or Sticky	Apply salt at 300-800 lb per two-lane mile, depending on accumulation rate. As snowfall continues and accumulates, plow and repeat salt application. If freezing rain, apply salt at 200-400 lb per two-lane mile. Consider anti-icing and deicing procedures as warranted.
Condition 3 Temperature Below 20 and falling Precipitation Dry Snow Road Surface Dry	Plow as soon as possible. Do not apply salt. Continue to plow and patrol to check for wet, packed or icy spots; treat them with heavy salt applications.
Condition 4 Temperature Below 20 Precipitation Snow, sleet or freezing rain Road Surface Wet	Apply salt at 600-800 lb per two-lane mile, as required. If snow or sleet continues and accumulates, plow and salt simultaneously. If temperature starts to rise, apply salt at 500-600 lb per two-lane mile, wait for salt to react before plowing. Continue until safe pavement is obtained.
Condition 5 Temperature Below 10 Precipitation Snow or freezing rain Road Surface Accumulation of packed snow or ice	Apply salt at rate of 800 lb per two-lane mile or salt-treated abrasives at rate of 1500 to 2000 lb per two-lane mile. When snow or ice becomes mealy or slushy, plow. Repeat application and plowing as necessary.
<i>Note: The light, 200 lb application called for in Condition 1 and 2 must be repeated often for the duration of the condition.</i>	

Most storms occur under Conditions 1, 2, or 3. But variations in temperature, precipitation, pavement condition or other factors are common. Management must depend upon well-trained maintenance crews to use initiative and imagination in coping with unforeseen problems.

Pavement will often freeze dry following a storm, if the last salt application is properly timed. Often, moisture on the pavement will turn to vapor and disappear as it freezes, leaving a completely clear, dry surface.

Keep an eye on the weather. Proper preparation for a storm is not possible unless management anticipates when it will arrive, how long it will last and the nature of its special characteristics. Arrange with the U.S. Weather Bureau, a local airport weather station or a private forecasting service to get complete, detailed reports during winter.

Some maintenance departments hire a private forecaster to assure a balanced and more localized weather picture. Some progressive agencies are using pavement sensors and local weather instruments to receive instantaneous road and atmospheric conditions for more precise snow and ice control operations.

It may also be useful to call 511 to get road conditions. Some states also have excellent 511 websites such as Minnesota (www.511MN.org) or Wisconsin (www.511WI.org) where road and travel conditions are described. In addition, the National Weather Service has a website (<http://www.nws.noaa.gov/>) that provides a comprehensive report of both local and surrounding conditions.

While weather conditions are generally measured 30 ft above ground, it is critical

in snowfighting to know what is happening where the rubber meets the road. Pavement temperatures are what counts when determining application rates. This requires some type of road surface sensors or gaining access to the Road Weather Information System (RWIS).

There are a variety of electronic sensors that can be used to measure surface temperatures. Hand-held or truck-mounted infrared, laser-based sensors are able to quickly get a pavement temperature and are very useful in establishing application rates.

RWIS is an exceptional system consisting of several meteorological stations strategically located alongside the highway that allows the DOTs to make more informed decisions during winter storms. Specialized equipment and computer programs monitor air and pavement temperature to make forecasts regarding how the winter storms will impact the highways. This provides the opportunity to make optimal use of materials, equipment and staff, and practice anti-icing and deicing techniques perfected through years of experience.

Any changes in weather conditions should be relayed to all personnel. If late afternoon reports indicate possibility of overnight snowfall, prepare equipment by attaching snowplows and spreaders before the workday ends. If weather forecasts indicate, a certain portion of the work force should remain on duty to start fighting the storm when it arrives. If the forecast indicates snow during the night, the work force should be sent home to get some rest, but alerted that they may be called back during the night. Arrange with the highway patrol, local police, sheriff's department or weather service to notify key personnel of storms that develop late at night. Ensure that someone is responsible for relaying the alert to the entire maintenance force, if and when the need arises. *

Pounds of Ice Melted Per Pound of Salt

Temperature Degrees F	One Pound of Sodium Chloride (Salt)
30	46.3 lb of ice
25	14.4 lb of ice
20	8.6 lb of ice
15	6.3 lb of ice
10	4.9 lb of ice
5	4.1 lb of ice
0	3.7 lb of ice
-6	3.2 lb of ice

Application of Salt

Rate of Application Per Two-Lane Mile	Coverage Per Cu. Yd. of Salt Per Two-Lane Mile
800 lb	2 1/2
700 lb	2 3/4
600 lb	3
500 lb	4
400 lb	5
300 lb	6
200 lb	10

Note: Salt meeting ASTM Specification D632 weighs approximately 80 lb per cubic foot.

Different materials will spread at different rates at the same setting, so spreaders must be calibrated with the material that will be used.

Spreader Calibration Procedure

Calibration of spreaders is simply calculating the pounds per mile actually discharged at various spreader control settings and truck speeds. It is carried out by first counting the number of auger or conveyor shaft revolutions per minute, measuring the salt discharged in one revolution, then multiplying the two and finally multiplying the discharge rate by the minutes it takes to travel one mile. An excellent example of a calibration chart in spreadsheet format can be found on the Salt Institute website at: <http://www.saltinstitute.org/images/calibrationchart.xls>. Operational spreadsheets can be found on the same page. A sample calibration chart is on this page.

With hopper-type spreaders, specific gate openings must be calibrated. Measure from floor of conveyor to bottom edge of gate.

Each spreader must be calibrated individually; even the same models can vary widely at the same setting.

Equipment needed:

1. Scale for weighing
2. Canvas or bucket/collection device
3. Chalk, crayon or other marker
4. Watch with second hand

Calibration steps:

1. Warm truck's hydraulic oil to normal operating temperature with spreader system running.
2. Put partial load of salt on truck.
3. Mark shaft end of auger or conveyor.
4. Dump salt on auger or conveyor.
5. Rev truck engine to operating RPM (at least 2000 RPM).
6. Count number of shaft revolutions per minute at each spreader control setting, and record.
7. Collect salt for one revolution & weigh, deducting weight of container. (For greater accuracy, collect salt for several revolutions and divide by this number of turns to get the weight for one revolution.) This can be accomplished at idle or very low engine RPM.

Multiply shaft RPM (Column A) by discharge per revolution (Column B) to get discharge rate in pounds per minute (Column

C), then multiply discharge rate by minutes to travel one mile at various truck speeds to get pounds discharged per mile.*

*For example, at 20 MPH with 30 Shaft RPM and 7 lb discharge – $30 \times 7 = 210 \times 3.00 = 630$ lb per mile.

Calibrating Automatic Controls

Automatic controls come with factory calibration cards that indicate the proper rate of spread for each setting. However, when there is a need to calibrate, use the following steps:

1. Remove or turn off spinner.
2. Set auger on given number, such as No. 2.
3. Tie sack or heavy canvas under discharge chute.
4. Mark specific distance, such as 100 or 1,000 ft.
5. Drive that distance with spreader operating.
6. Weigh salt collected in sack or canvas.
7. Multiply weight of salt by 5.3 (in case of 1,000 ft) or 52.8 (in case of 100 ft).

This will be the amount of salt discharged per mile, which remains constant regardless of speed, but calibration must be done for each control setting. *

Calibration Chart

Agency: _____

Location: _____

Truck No.: _____ Spreader No.: _____

Date: _____ By: _____

Gate Opening (Hopper Type Spreaders)			Pounds Discharged Per Mile									
Control Setting	A Shaft RPM (Loaded)	B Discharge Per Revolution (Pounds)	C Discharge Rate (lb/min)	Minutes to Travel One Mile								
				5 mph x 12.00	10 mph x 6.00	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	40 mph x 1.50	45 mph x 1.33
1		This weight remains constant										
2												
3												
4												
5												
6												
7												
8												
9												
10												

7 GUIDELINES FOR SALT APPLICATION

Timing is crucial in applying salt. Ideally, brine is sprayed as an anti-icing treatment prior to the storm's arrival. If that is not possible, then salt should be spread as soon as a storm begins in order to prevent bonding of snow or ice to the pavement. The salt will quickly produce brine or keep snow mealy, allowing for efficient plowing.

The melting action of salt applied early in a storm works from the pavement surface up so snow and ice do not form hardpack.

There are times and storm conditions where salt alone is the only answer to keeping the pavements clear. For example, freezing rain cannot be plowed and salt is the only solution for clearing the roads when it occurs.

Anti-icing is rapidly becoming the best and most popular means of preventing ice-pavement bonding.

The best advice is to be prepared to mobilize all forces as soon as a winter storm approaches.

There are no easy answers or solutions with snow and ice control because there are too many variables. It has been estimated there are over 66,666 different storm conditions – pavement temperature, ambient temperature, pavement type, solar radiation, traffic volume, traffic speed, wind direction and velocity, type of precipitation, topography, lake or ocean effect, shaded areas (by mountains, trees or buildings) and wind chill factor, to name a few.

Snow and ice control is a very complex issue and those people on the front line need the best information possible.

Salt is usually applied at the rate of 300 to 800 lb per two-lane mile. As temperatures drop, either the quantity of salt or the frequency of application must be increased.

Anti-icing, that is spraying brine on pavement before the storm arrives, requires anywhere from 1/3 to 1/4 the material of deicing, making it the most cost-effective option for improving winter traffic safety.

Ideally, with any deicer, at the end of the storm all material should be completely used. Since storm forecasting is not precise, some residue may remain on the surface after



some storms. That residue, if not blown off or washed away, will be effective in helping prevent bonding of ice and snow in the next storm. A deicer only has residual effect if too much was applied for the storm condition.

Prewetting salt with brine speeds the reaction time of salt and also keeps salt from bouncing off the road so more of it is available to do the work. See Section 10, page 18, for details on this deicing procedure.

There may also be a combination of applications of any of the above. Most agencies agree that early anti-icing spraying is most effective and that prewetting of salt provides a faster, higher level of service at all temperatures.

Spreading can be done full-width or windrow. Both have strengths depending on conditions. Pay special attention to spinner speeds. A spinner that revolves too fast will throw salt over a wide area, possibly wasting material. You may correct overthrow by adjusting the drop location on the spinner by using your directional baffles or reducing spinner speed. Traffic density and highway design largely determine the spreading pattern required.

A **windrow** of salt applied in a 4-8 ft strip along the centerline is effective on two-lane pavements with a low to medium traffic count. Less salt is wasted with this pattern and quickly gives vehicles clear pavement under at least two wheels. Traffic will soon move some salt off the centerline and the salt brine will move toward both shoulders for added melting across the entire road width.

The **full-width** spreading pattern is used most often on multiple-lane pavements with medium to high traffic volumes. Melting action is obtained over the full pavement width. Vehicles tend to stay in line to clear wheel paths in the lanes.

Often the full width pattern is used when trying to get salt down under a storm. But be careful not to waste salt when using this pattern.

Play the wind in spreading. A strong wind blowing across a street or highway can cause salt to drift as it comes out of the spreader, pushing it onto the shoulder or into a gutter. This is particularly true in rural areas where there are few windbreaks. How the wind affects spreading depends on both wind velocity and pavement condition. Spreader operators should play the wind to put salt where it will do the most good.

Because of the much greater control inherent to the spray process, anti-icing is best applied with full-width stream nozzle systems to maintain a small width of bare pavement to reduce slipperiness. A fan spray is not

recommended and care must be exercised during windy conditions.

Give salt time to work. Time plowing operations to allow maximum melting by salt. When you plow salt off the pavement, you waste the deicing material and increase the cost of snow removal.

Know when to plow and reapply salt. The need for another salt application can be determined by watching melting snow kicked out behind vehicle tires. If the slush is soft and fans out like water, the salt is still working. Once the slush begins to stiffen and is thrown directly to the rear of vehicle tires, it is time to plow and spread more salt.

Has the weather changed? Remember that salt application rates may have to be increased at night, on sunless days and when the temperature drops sharply. Without the sun, the effect of solar radiation and warmth is lost. At night, traffic usually diminishes, minimizing another heat source that helps melt ice and snow. It is important to remember that pavement temperatures are seldom the same as air temperatures — a critical thought when

choosing the options for snow and ice control — it is the pavement that will be treated.

Don't overlook salt's anti-skid value. For years, maintenance people have observed that salt, applied as an ice melter, also gives anti-skid protection. Tests conducted in cooperation with the National Safety Council show that salt, applied at normal deicing rates, gives as much anti-skid protection as abrasives. The anti-skid effect of salt is immediate as it starts melting snow or ice.

Safeguard the environment. The way salt is spread can make the difference between whether the public appreciates or condemns snowfighters' efforts. Overuse and misuse ignore concern for the environment. Proper calibration of spreading equipment and good storage can avoid most problems.

There is no correlation between yearly snowfall and the total quantity of salt used. The type of storm dictates frequency of application and total amount of salt necessary. A freezing rain or ice storm may require enormous amounts of salt, perhaps even more than a prolonged snowstorm. There is no way to combat freezing rain other than salt use. ❄️



8 SPECIAL SPREADING AND PLOWING PROBLEMS

Salt bridges first. Bridges freeze long before road surfaces because they do not hold warmth as a roadbed does, since cold air reaches both the top and bottom surfaces of bridge decks. They should receive early attention and an application of salt. Bridge decks may ice over even when there is no precipitation because of high humidity and low temperatures. (Or under certain other conditions, bridges will frost over without precipitation and must be salted.)

Salt on the high side of elevated curves. Salt brine will flow down and across a banked curve. If salt is spread down the centerline, everything above it will remain icy. Spread salt on the high side of the curve and let gravity do the rest of the work.

Leave no gaps. Operators must go beyond their assigned areas, if necessary, to plow or salt a gap that has not been treated for some reason. A short, neglected stretch of roadway can be very hazardous to an unsuspecting motorist.

Watch for drifting. In continued high winds, maintain a patrol to watch for drifting and slick spots, even after the pavement has been cleared. Treat icy buildups with a salt application. If the highway has a blacktop or stabilized shoulder, drifting may be controlled with a salt application on the shoulder to form a melting barrier.

During some very low temperature storms with dry blowing snow, the use of salt may not

be appropriate. The dry snow may blow off the pavement if no salt is used.

Avoid slick conditions from buildup of ice or packed snow by applying a salt application heavy enough to prevent refreezing.

Traffic icing is very dangerous. Occasionally, under certain weather conditions, a paper-thin sheet of ice forms in wheel paths on a bare pavement even when

Make a list of trouble spots that operators should salt first during storms. Make sure all personnel understand that bridges, intersections, ramps, hills and curves come first. Have operators patrol highways rather than wait at maintenance areas for direction.

It is far better to have equipment on the road when snow begins than in the maintenance yard. Nothing is more reassuring

to motorists than to see pre-storm anti-icing sprayers or loaded spreaders and plows patrolling prior to storms.

Give interchanges special attention. Salt on and off-ramps as quickly as possible. A safe road or street is of little value without safe entrances and exits.

Can trucks be kept out of the way? Intelligent transportation systems have been developed to do just that. Basic management controls such as truck navigation, traffic light controls, container management systems, variable message signs

or speed cameras as well as monitoring applications such as security CCTV systems which have been designed to manage trucking logistics. Additionally, predictive techniques are being developed, to allow advanced modeling and comparison with historical baseline data. *



pavement looks clear. This black ice formation can be deadly. Maintenance operators should be instructed to watch for this condition and to apply salt immediately when it is detected.

Get equipment on the road. Once a word of an impending storm has been received and plows are mounted and trucks loaded, get vehicles out of the yard and onto their plowing and spreading sections as soon as possible. Delay in getting to critical areas may cause severe traffic tie-ups.

A relatively new weapon in the snowfighter's arsenal in North America is anti-icing. But it has a long history of keeping European roads safe and passable.

Anti-icing differs significantly from deicing because brine is applied before precipitation to prevent the formation or development of bonded snow and ice on the road surface. It is a proactive approach to snowfighting and is often the first in a series of strategies employed for a winter storm. By applying freezing point depressant materials before a storm it is possible to prevent the bond from forming between the pavement and snow or ice. Research has shown that timely applications of anti-icing materials can cut the cost of maintaining a safe road surface by 90% compared to traditional deicing. Liquid sodium chloride (NaCl) is the most effective choice for anti-icing above 15°F.

Anti-icing has many advantages.

- Anti-icing returns road surfaces to normal faster, resulting in fewer accidents and delays.
- Anti-icing can reduce airborne dust and salt particulates.
- Salt needs moisture to be effective. Applying brine jumpstarts the melting process.
- Brine sticks to the road surface. It will not be as easily blown off the road by wind or traffic, so material is more efficiently used.
- If the storm is delayed, salt residue remains on the road ready to begin work when precipitation begins.
- Crews can begin treatment in advance of a storm. Because anti-icing prevents the bonding of snow and ice to pavement, snowfighters have less work to maintain safe roadways as the storm progresses.
- Increased efficiency results in use of less deicer and manpower, therefore lowering the cost of maintaining safe road conditions. The use of less deicing materials also minimizes environmental concerns.

Products available for use in an anti-icing program are sodium chloride, calcium chloride, magnesium chloride, potassium

acetate, and calcium magnesium acetate.

Each product has its own advantages and disadvantages. The most common material in use is sodium chloride (salt) in the form of a brine made from a mixture of rock salt and water. Salt brine is effective to -6°F and is a proven anti-icing agent in use throughout the snowbelt.

Some agencies use calcium or magnesium chloride in a brine solution which is effective down to -6°F, but is more than six times as expensive than salt, and is more difficult to handle. Also, calcium and magnesium chloride residue on road surfaces can attract moisture at lower relative humidity than salt resulting in dangerous, slippery conditions under certain circumstances.

Salt Brine Manufacture

Salt brine is made by mixing rock salt or solar salt with water. The process is simple: the resulting brine should be approximately 23% NaCl.

The proportion of salt to water is critical to the effectiveness of the brine. Too much or too little salt affects the freeze point depressing qualities of the brine. The proper brine mixture is 23.3% salt content by weight. This is the concentration at which salt brine has the lowest freezing point, -6°F. Can we keep adding salt to water until the freezing point goes down much further? No. The solubility of salt in water decreases with decreasing temperature. We eventually reach what is called the eutectic point. This is the point at which a solution achieves a maximum salt concentration. Any colder and salt will begin to leave the solution and raise the freezing point. At the eutectic temperature, ice, saltwater, and solid salt exist in equilibrium. For water, the eutectic temperature is -6°F. The percentage of salt is measured with a salometer, a specialized hydrometer, until a 88.3% measurement on the salometer is obtained. This results in the proper 23.3% salt content.

Commercial brine makers are available at a cost of approximately \$5,000. Many agencies have made their own brine makers using water tanks and PVC pipe for substantially lower cost. Brine is usually made at the local

maintenance facility sites and stored in large tanks in locations convenient for loading into saddle tanks on the sides of the V-box or anti-icing equipment. It is essential to clean out brine makers after brine is prepared to reduce the potential for corrosion.

Application Equipment

Brine applicators are commercially available for about \$1,500. Some agencies have manufactured their own application equipment using large tanks and PVC piping. Some equipment is designed to be loaded onto the bed of spreading trucks, towed behind maintenance equipment or permanently mounted on truck beds. It can be as simple as a gravity fed spraying system with a operator controlled cut-off valve or a more complex (and more controllable) pump

Hydrometer/Salometer Chart for Salt Brine		
% Salt	Hydrometer Specific Gravity	Salometer Using 0-100%
0	1.000	0
1	1.007	4
2	1.014	7
3	1.021	11
4	1.028	15
5	1.036	19
6	1.043	22
7	1.051	26
8	1.059	30
9	1.067	33
10	1.074	37
11	1.082	41
12	1.089	44
13	1.097	48
14	1.104	52
15	1.112	56
16	1.119	59
17	1.127	63
18	1.135	67
19	1.143	70
20	1.152	74
21	1.159	78
22	1.168	81
23	1.176	85
24	1.184	89
25	1.193	93
26	1.201	96
27	-	100

driven sprayer system. Fan sprayers are not recommended. Control should be available to vary spreading rates from 25 to 60 gallons per lane mile.

If large, horizontal tanks are used in the design, consider installing baffles inside the tanks to help prevent the liquid from suddenly shifting in the tank, creating a hazardous control situation for the operator.

Application

Accurate weather and road surface information are critical for the efficient use of anti-icing chemicals. Road surface temperatures, precipitation amounts and form, wind conditions, and road environment (sunlight exposure, surface condition, bridges, etc.) all affect the use and application of anti-icing measures.

Understanding the freeze point depressing qualities of brine is important to its use and application as an anti-icing agent. (See the Phase diagram below.) As you can see from the chart, the minimum freeze point of salt brine is -6°F at a concentration of 23.3%. Road surface temperatures are indicated on the side of the chart, solution concentrations along the bottom. The line represents the freeze point of the solution at a given temperature. The colored portion in the center of the chart shows the melting range of brine solutions. The area to the left shows the results of a solution with too little salt, the road surface will refreeze unless more salt brine or deicing salt is applied. The area to the right shows the results with too much salt, and once again the surface will freeze without the introduction of more moisture. As you can see, additional precipitation and heavy traffic can dilute the brine solution allowing the road to refreeze.

ADDITIONAL PRECIPITATION ALWAYS RESULTS IN A DILUTION OF BRINE AT THE ROAD SURFACE.

Weather information is getting better with everything from air temperature, dew point, optical weather identifiers, to pavement temperature, surface status, and chemical information being available. Some agencies

utilize remote television cameras to monitor traffic and bridge conditions. This information will help agencies accurately determine the appropriate application of anti-icers.

Do not apply anti-icer under blowing conditions, particularly in areas prone to drifting and anywhere else that might be problematic for salt, such as all areas subject to wind issues.

Don't apply too much or the roadway may become slippery. Always follow application recommendations.

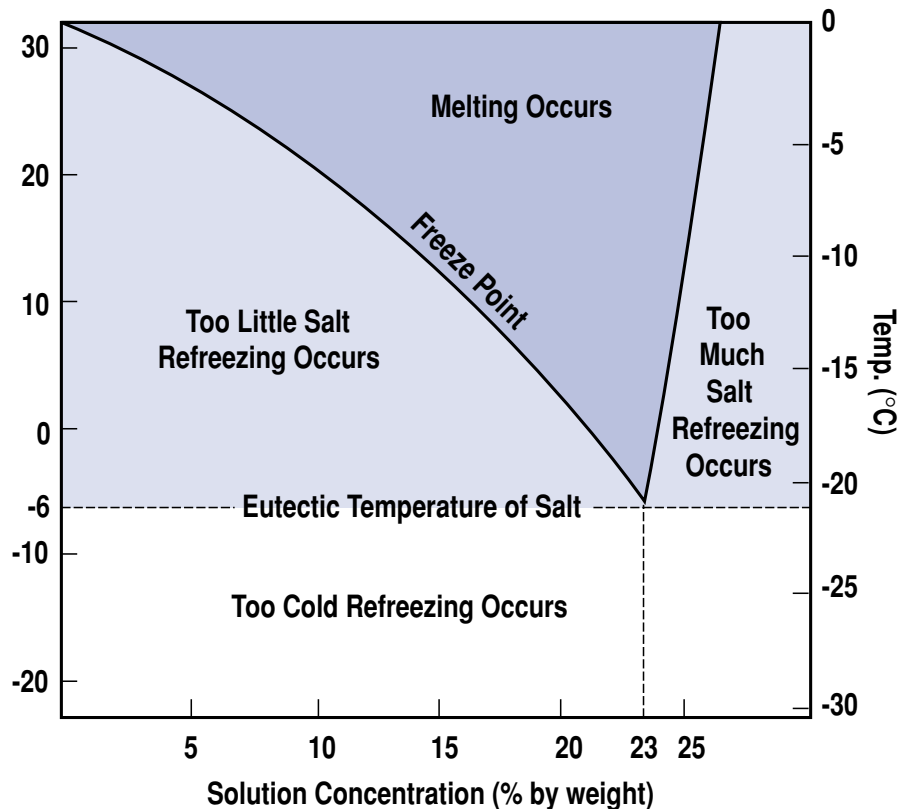
Don't apply CaCl_2 or MgCl_2 to a warm road (above 28°F pavement temperature). It can become very slippery and cause crashes!

Summary

Anti-icing measures are an important weapon in the snowfighter's arsenal. The appropriate use of anti-icing techniques results in:

- Returning to bare pavement conditions more quickly, saving lives and reducing property damage due to fewer accidents, as well as the reduction of traffic delays and the resulting reduction of losses to local economies;
- Reduction in the quantity of deicer use, resulting in cost savings and less environmental concerns; and
- Reduction in the manpower necessary to maintain safe road conditions, resulting in less overtime costs, less operator fatigue and safer working conditions. *

Phase Diagram for Salt



10 DEICING-PREWETTING

Once snow has accumulated and bonded to the road or an ice storm has glazed road surfaces, deicing operations must begin to restore safe driving conditions. The bond between snow and/or ice and the pavement surface must be destroyed by chemical or physical means or a combination of the two.

More than a dozen chemicals have been tested for deicing use. The most common products used are sodium chloride, calcium chloride and magnesium chloride. Sodium chloride in the form of rock salt or brine (see previous chapter) is by far the most commonly used chemical in deicing operations due to its lower cost and proven effectiveness. Therefore, in the words of the Transportation Research Board in its 1992 analysis of deicers, salt remains the “deicer of choice.”

Abrasives have no melting effect for deicing operations; in fact research by the Strategic Highway Research Program (SHRP) and the University of Wisconsin suggests that sand inhibits the melting process of deicing materials.

Choosing the Proper Application

Salt can be applied in solid, prewetted solid, or liquid form. Application methods are determined by weather and road conditions as well as equipment available. Salt needs moisture to provide melting action. Deicing rock salt or solar salt dissolves in road surface moisture to form a brine which melts snow and ice to form more brine which continues the process. Once salt has penetrated the packed snow and ice to make brine on the pavement surface, the bond will be broken and removal operations can be successful in restoring bare pavement conditions.

Forecasted conditions and road surface temperatures at the time of treatment determine whether winter maintenance materials should be applied in solid, prewetted solid or liquid form. The type of precipitation event, dry snow, wet snow, ice, sleet, freezing rain, etc., must be considered. Keep in mind that changing conditions will affect operations. Falling temperatures can cause refreezing. Additional precipitation can dilute

winter maintenance materials, rendering them ineffective. Refer to the Phase Change diagram in the previous chapter for assistance in determining the proper course of action.

If the road surface is wet and temperatures will not cause refreezing, then application of dry salt is appropriate. Necessary moisture is already present so brine will be formed immediately and melting action can begin. The application rate will be determined by the amount of snow and ice coverage. Keep in mind the reduced mobility effect as dilution of deicing salt occurs.

If snow pack and ice is solid, or temperatures will fall to the point that refreezing will take place, then prewetted solid application of deicers may provide more rapid results. Adding moisture to the salt either at loading or at the spinner when applied will jump start the deicing process by providing more moisture to begin the melting process.

Spraying liquids is not recommended for packed snow as the liquid destroys surface friction and the brine may become so diluted before melting action is completed that refreezing could occur. Application of brine is an effective treatment for black ice conditions. Although salt can melt ice at temperatures as low as -6°F , the practical limitation of brine application is considered by the Federal Highway Administration to be around 15°F . Below that temperature, pre-wet with calcium chloride or calcium magnesium chloride mixed with sodium chloride.

Deicers should be applied close to the crown or high point of the road. The resulting brine will run downhill from the crown to the rest of the surface. Spinner speed should be low enough to ensure that deicing materials remain on the road surface. Spinner speed and application rates should be higher at intersections and other high traffic areas to spread deicing material over a larger area or in higher concentrations as required by the conditions. However, use of the BLAST override on automatic controls while stopped at a stop sign or light is not appropriate.

Road conditions, temperature, amount of snow and ice cover, storm progress, and traffic conditions all affect deicing application rates.

The tables in section 5 of this Handbook, will assist you in determining appropriate application rates.

Materials Selection

Generally, all deicers work in the same way. They depress the freezing point of water and turn snow and ice into a liquid or a semi-liquid slush. Solid chemical salts infiltrate down through ice and snow, dissolving to form a strong brine solution which spreads out under the ice or hard-packed snow and breaking the bond to the road surface. Once the bond is broken, the ice and snow can be plowed off or removed by other means. By applying material prior to the storm, we can prevent the bond to the road surface and melt the snow and ice as it comes in contact with the brine.

Agricultural byproducts work in a similar fashion. The resulting solutions act by depressing the freezing point of snow and ice. These products are usually used in combination with other materials.

Although all these materials work in much the same way, they vary widely in performance. Several factors are considered in determining performance, such as effective temperature range, speed of action, amount of material required, and duration of melting action.

Other important criteria for material evaluation include: availability, cost, infrastructure and environmental impacts. Each community will place a particular emphasis on each of the criteria to suit their own specific needs. At times, their needs may change depending upon shifting political priorities. The ability to be able to make a rational decision on material selection to closely fit with ongoing needs is of tremendous importance to winter maintenance planners.

In order to come to grips with this issue, a consortium of state DOTs commissioned a study to develop an evidence-based decision tool for materials selection. This was published by the Transportation Research Board of the National Academy of Sciences in May, 2007. The full report can be downloaded from: http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_577.pdf. Now agencies can objectively compare the de-icing chemicals they use in terms that each agency defines for

itself to be important. The computer program (called the Material Selections Wizard) crunches the data based upon the agency's set of priorities.

This computer program can be downloaded from the Salt Institute website: <http://www.saltinstitute.org/snowfighting/index.html>. It is also available at the TRB website: http://www.trb.org/news/blurp_detail.asp?id=7739.

Here is an example of how the new Materials Selections Wizard works.

The winter maintenance agency has had budget cuts and decides that the following priorities reflect their particular needs — see Chart 1.

Price is the primary concern (45%), snow- and ice-melting performance is almost but not quite so important (35%), while environmental (11%) and infrastructural (9%) are somewhat lower down on the overall scale of things.

Using the Materials Selection Wizard, the data is inputted and the following results are obtained showing which material will fit the agency's needs for which temperatures — see Chart 2.

The wizard makes an informed choice based on specific priorities. It is a choice that can be defended before City Council. Citizens value their hard-earned dollars and expect them to be spent wisely to keep roads open and safe while safeguarding the environment. The City Council and the citizens determine the policy. This tool turns the policy into a practical and functional choice.

As another example, here is an extreme environment/infrastructure priority model. It disregards deicer costs and weights performance low (25%, with the logic that a lower weighting would be irresponsible since the material must perform its life-saving deicing mission). Environment and infrastructure together account for three-fourths of the total weighting (split evenly with 37.5% weight for each).

Here is how the various materials stack up with this set of priorities — see Chart 3

So, the choice belongs to the agency that can now be assured that at the temperatures to be encountered, they are choosing materials that comply with their community's particular priorities.

Chart 1

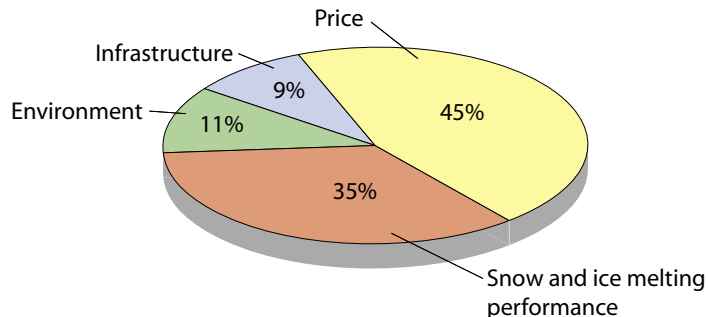


Chart 2

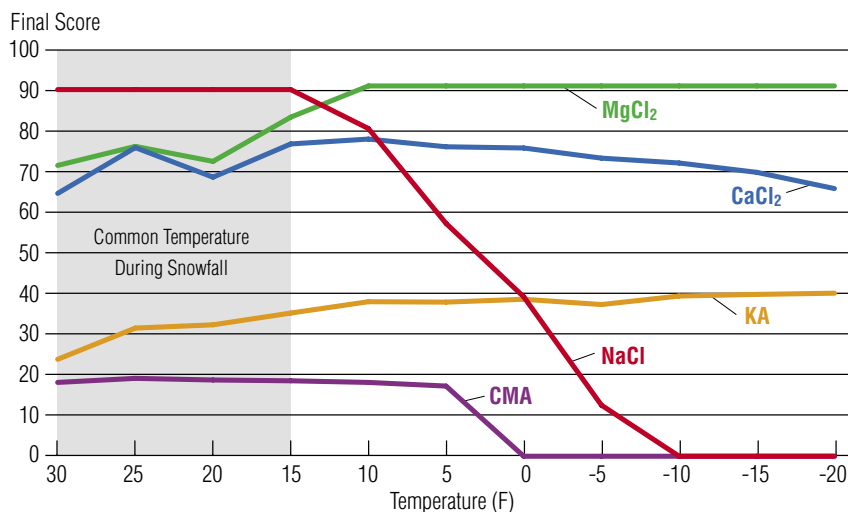
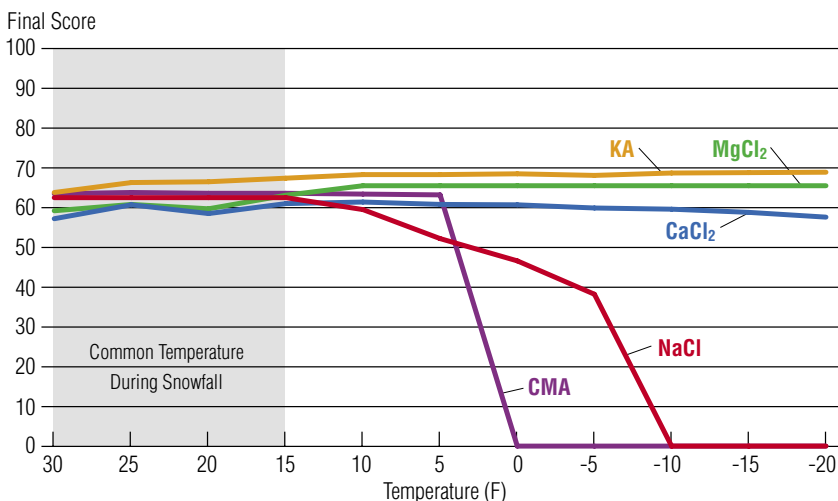


Chart 3



11 AFTER THE STORM

Equipment Used

Solid deicers or pretwetted salt is applied with spreader trucks. If the load is wetted, then no additional equipment is necessary. Saddle tanks and a sprayer at the spinner are necessary if brine is applied to the salt at the time of application to the roadway. Brine can be applied with tank trucks or towed equipment using the same equipment discussed in Chapter 9.

Summary

Use of salt is a proven snowfighting technique with many advantages:

- Returns roadway surfaces to bare pavement conditions more quickly, thereby reducing the number of accidents and property damage, and saving lives. Research has shown that use of salt as a deicer more than pays for itself;
- Lowers manpower costs by reducing the time necessary to restore dry pavement conditions;
- Eliminates or greatly reduces cleanup costs;
- Compared to alternatives, salt is safer to handle, and kinder to the environment when properly used.

Prewetting may enhance salt use:

- Salt can be spread more uniformly with less waste on shoulders and in ditches because wetted salt sticks to the pavement;
- The amount of dry materials used can be cut by 20-30% (IADOT) because of the dual action of added brine and more materials remain on roadway;
- Works faster because more brine is present;
- Driving/spreading speeds can be increased because salt stays on the roadway. *

Most snowstorms occur at 20°F or above, with the temperature dropping most severely after the snow stops.

After the storm, with the pavement clear and dry, is the time to wing back shoulders, clear structures and haul snow away from critical areas to make room for future snow storage or snow removal.

In plowing, a windrow of snow is often left on each side of bridges. These windrows reduce the usable roadway width on the bridge. Moreover, if allowed to remain, they will later melt and form ice. Remove this snow as soon as possible.

Caution. Do not dump material from overhead bridges onto roadway or railroad tracks below. Hand shovel the snow away, if necessary, to ensure all drains in the bridge floor are open and free-draining.

Clear snow from raised medians to prevent drifting. Also clear snow from barrier walls and traffic dividers to reduce later melting and refreezing and to improve driver visibility.

Clear those drains! It is vital that roadway drains and catch basins be kept open to allow melting ice and snow to run off. When water ponds and puddles around drains, falling temperatures may cause it to refreeze. A salt application on frozen drains, catch basins and culverts frees them of snow and ice.

Accurately record all material used. Hazards, such as raised utilities or low hanging branches, and problems encountered such as area-specific snow accumulations should also be recorded.

Discuss opportunities to improve operations.

Carry out interim cleaning and maintenance of equipment.

At end of season, do full cleaning and maintenance of all equipment and ensure all remaining supply piles are securely placed on impervious pads and covered. *

12 A WORD ABOUT SAFETY

The whole purpose of snow and ice removal is, of course, to provide safe travel for motorists. In doing this, those in maintenance must not overlook their own safety; neither must they overlook the possibility that in trying to provide safe pavement they may be creating another safety hazard.

Become familiar with a few “do’s and don’ts” that can make your work far safer:

- Check all equipment before each use. Make sure lights, brakes, windshield wipers, exhaust systems, tires, chains and steering are safe.
- Promptly report all mechanical trouble.
- Remember that speed can kill, especially in a snowstorm and at night.
- Resist the urge to get the job done in a hurry.
- Respect rights of others. Be considerate of motorists who have trouble driving in snow; report stranded motorists when possible.
- Keep first aid kits completely stocked. Check fire extinguishers and flares often.
- Observe traffic laws.
- Watch for signs of fatigue in equipment operators. A limit of twelve continuous hours on duty seems fairly common in public works agencies in the snow belt, although some organizations permit longer work periods. Usually, however, the routine is twelve hours on and twelve off. *

13 KEEP THE PUBLIC INFORMED

Publicize snow emergency procedures and regulations. Keep broadcasters and newspapers periodically informed of snow clearing progress and specific problem areas. This way, motorists will know on which routes they will be able to travel with the least difficulty. Advance publicity on snow clearing priorities will reduce time-consuming calls from people demanding to know when their streets or roads will be cleared.

Before storms arrive, pass on information about approaching snow in time for schools, industry and government agencies to decide whether or not to remain open or to close early.

Make contact with other agencies. Long before winter, meet with representatives of other public agencies to discuss means of cooperating in snow and ice removal. Take the initiative to let others know of your plans and to enlist their cooperation.

Consider inviting these people to the pre-winter session: a representative of the top elected public official in your area, the local civil defense director, those in charge of bus transportation for school systems, police and fire officials, emergency road service managers of nearby clubs of the American Automobile Association (AAA), officers from local military units and news media representatives.

Snowfighters are not miracle workers. They are dedicated, hardworking human beings who pit their will against the forces of nature — and usually win!

The real record of their accomplishment is not the tons of snow removed or the miles of pavement kept clear or number of streets plowed. The achievement of open highways that allow business, industry and government to function and people to travel safely and without undue delay is the testament of good snowfighting.

There are no comprehensive data to support the number of lives saved through the efforts of public works and highway agencies, yet, lives are saved and you may have saved one of them.

The findings of one quality study are displayed below. There is no doubt about the benefits of deicing. Even calculating all the known costs of deicing such as vehicle and bridge corrosion and environmental damages, the benefits of using deicing salt are more than 18 times the cost of providing this essential public safety service.

Suggested Program Outline For Fall Training Sessions

I. The Importance of Coordination

- Know Your Plowing and Spreading Routes
- Effective Radio Communication
- The Storm Warning System
- Working with Police, other Public Agencies and the Media

II. Equipment—Its Operation and Maintenance

- Plows
- Spreaders, Sprayers and Their Controls
- Loaders
- Emergency Repair and Refueling Stations
- The Importance of Preventive Maintenance

III. Application Procedures

- How Salt Works
- How and When to Salt
- Anti-Icing vs Deicing
- Application Rates
- Special Storm Conditions
- Special Deicing Problems (Bridges, Elevated Curves, Ramps, Intersections)
- When to Re-Apply Salt

IV. Review of Winter Maintenance Policy

- Snow Emergency Routes
- Parking Ordinances
- Procedures for Helping Motorists
- Importance of Personal Public Relations by Maintenance Personnel

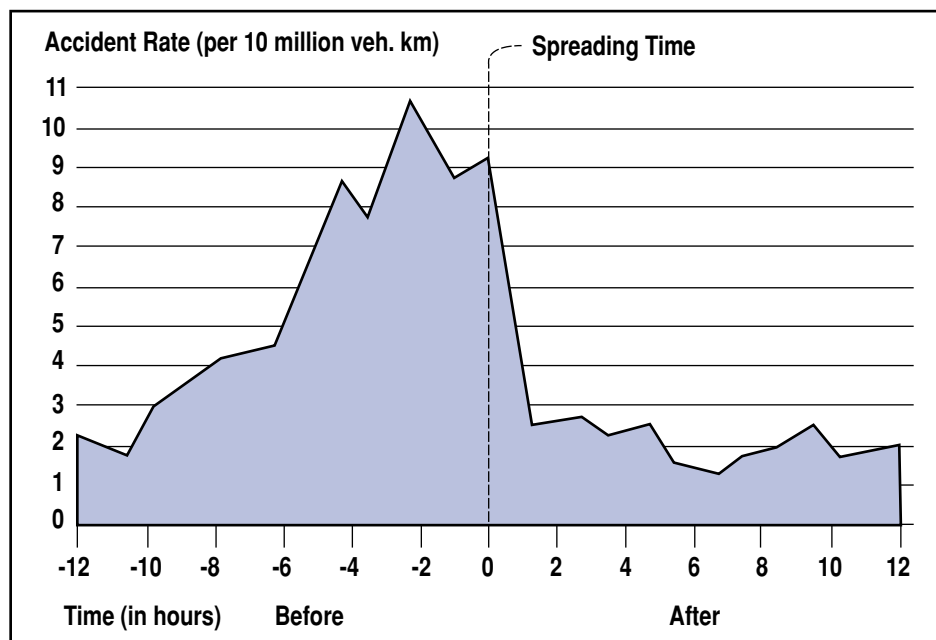
V. On-the-job Safety

- Safety Equipment
- Safety Practices

VI. Discussion, Questions and Answers

To assure yourself that your department is ready for winter, you might have superintendents or foremen complete a check list showing their progress in pre-winter preparations. A suggested check list similar to that used by a number of cities and states, is illustrated on pages 22 and 23. *

Accident Rate Before and After Salt Spreading



SNOW AND ICE CONTROL CHECK SHEET



(Answer YES or NO except where more information is requested)

Organization: _____

Please complete, sign and return this form to _____ by _____
(DATE)

Miles on Clear Pavement Standard	Estimated Winter Salt Requirement (Tons)	Salt On Hand	Salt On Order	Abrasives On Hand	Abrasives On Order

STORAGE					
FACILITIES AVAILABLE			FACILITIES NEEDED		
TYPE	NUMBER	CAPACITY (TONS)	TYPE	NUMBER	CAPACITY (TONS)
BUILDINGS			BUILDINGS		
CRIBS			CRIBS		
PADS			PADS		
GRAVITY BINS			GRAVITY BINS		
TOTAL TONS			TOTAL TONS		

- If cover material needed: Type _____
- Condition of salt on hand: Dry Wet
- All mechanical parts, storage facilities, such as hinges, slides, conveyors are operating properly and ready for winter use Yes No
- If no, explain needed repairs. _____
- Area lights are in working condition Yes No
- Storage areas are clean and cleared of items that might cause accidents or impede operations Yes No
- Drainage is adequate at storage sites Yes No
- Have there been public complaints about any storage area? Yes No
- If so, please explain and give dates. _____
- Traffic warning or control signs are posted at entrances and exits to storage areas Yes No
- Engine heaters and shed facilities are available Yes No

EQUIPMENT

1. LOADERS

- Loaders of all types have been checked and needed repairs made Yes No
- Describe repairs not yet completed: _____

2. SPREADERS

- All spreaders have been calibrated and needed repairs made Yes No
- Spreading rates posted in cab, spinners checked for width of spread Yes No
- Following items have been inspected and tested on all spreaders:
 - Spinners and auger Yes No
 - Sheet metal Yes No
 - Gasoline Engines Yes No
 - Cab and other operator controls Yes No
- Number of spreaders ready for operation: _____
- Hydraulic systems Yes No
 - Filter element in systems (replace if necessary) Yes No
 - Oil-drain and flush hydraulic system, fill with oil of manufacturer's recommendation. Yes No

3. SNOWPLOWS & UNDERBODY BLADES

- A. All plows have been checked and needed repairs made Yes No
- B. Blade edges checked and replaced if necessary Yes No
- C. Plows have been placed on trucks to be sure all attachments and fittings are available Yes No
- D. All hoses, cylinders and fittings have been inspected and tested Yes No
- E. Reversible plows work properly and freely Yes No
- F. Plow ends are marked with flags Yes No
- G. An adequate stock of all types of blades and bolts is on hand Yes No
- H. Number of plows ready for operation. _____

4. SAFETY DEVICES

- A. All winter maintenance vehicles are equipped with lights according to official guidelines Yes No
- B. If not, describe preparations: _____

- C. Wiring and connections have been inspected Yes No

D. Following items have been inspected on all equipment:

- Headlights Yes No
- Tail lights Yes No
- Stop lights Yes No
- Turn lights Yes No
- Rear & side view mirrors Yes No

- Rotary lights Yes No
- Flashing lights Yes No
- Instrument lights Yes No
- Dome lights Yes No

E. All trucks are equipped with:

- Flares Yes No
- Safety Vest Yes No
- Tire chains Yes No

- Flashlight Yes No
- First aid kit Yes No
- Tow chain Yes No

F. Following items have been inspected and found in working order:

- Windshield wipers Yes No
- Tires Yes No
- Defroster Yes No
- Exhaust system Yes No

- Wiper blades Yes No
- Heater Yes No
- Fuel gauge Yes No
- Front end alignment Yes No

ASSIGNMENTS AND TRAINING

- A. Personnel and equipment have been assigned to specific sections Yes No
- B. Operators have been informed of their duties and responsibilities Yes No
- C. All operators understand the operation of equipment and work procedures Yes No
- D. Dry runs have been made to check routes Yes No
- E. Operators and supervisory personnel understand that each spreader must be calibrated separately, using salt, on a dry run Yes No
- F. Operators have been instructed to clean and lubricate all equipment immediately after each storm Yes No
- G. Operators have been told to report needed equipment repairs immediately Yes No
- H. All operators have received safety instructions Yes No
- I. Reserve operators are fully trained Yes No

WEATHER WARNING AND MOBILIZATION OF CREWS

- A. Arrangements have been made with a U.S. Bureau Station or other forecaster to get advance warning of storms Yes No
- B. Arrangements have been made with local police, sheriff's department, highway patrol or others to notify you in the event of a night storm Yes No

List checks and maintenance procedures that have not been completed on a separate sheet and attach to this form.

Signed _____ Title _____

Signed _____ Title _____

Signed _____ Title _____

STORM RECORD



Storm No:	Sec:	Div:	Date:
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1. Time	AM	PM	Day of Week	2. Location	Miles
Storm Started				From:	
Storm Ended				To:	
Road Cleared					

3. Description					
Dry Snow			Temp	Wind	
Wet Snow		Max:	Min:	Direction:	Velocity MPH
Sleet		Depth of Snow		Visibility	
Freezing Rain		Avg (in)	Drifts (ft)	Good:	Fair: Poor:

4. Procedures				5. Results		
	No of Apps	Time		Excellent	Good	Poor
Salt		From: To:	Salt			
Plowing		From: To:	Plowing			
Abrasives		From: To:	Abrasives			

6. Labor, Equipment & Materials							
Personnel	Reg Hrs.	O.T. Hrs.	Total	Equip. No.	Type	Hours	Material (TONS)
							Salt
							Abrasives
Total							

Comments:

Completed by: _____
Name, Title

Publications Available from the



Refer to www.saltinstitute.org/34.html for further details and other literature

Highway Salt and Our Environment

Describes effects of deicing salt, if over used, on plants, trees and grasses, and water supplies. Also discusses auto corrosion, damage to pavement and bridges and the problems created by other deicers and abrasives. Revised 2004. [Note: 2004 version available as a free PDF download in English 159 KB and 1 MB].

Salt Storage Handbook

A guide for handling and storing deicing salt. Dozens of storage ideas. Revised 2006. [Note: available as a free download as a 622 KB PDF file for viewing or a 2 MB file to print].

The Snowfighter's Handbook – 40th Year Edition

Manual for winter maintenance. Includes pre-winter planning, equipment scheduling and maintenance, special plowing and spreading problems and environmental considerations. Revised October 2007. [Note: available in English as a free download in zipped PDF format, 84 MB].

Snowfighter's CDs

A set of two CDs containing five snowfighter training programs in MS PowerPoint, four PDF format and MS Word format handout documents, PLUS the Institute's *Snow fighters Handbook*, *Salt Storage Handbook*, *Snowball Snowfighter* PowerPoint training presentation, *Highway Salt and Our Environment* and other valuable winter maintenance materials. The CDs collect all these materials for convenience, but all these materials except the newest "Operations" PowerPoint training program are also available for free download and available for free download in our Snowfighting Training web pages.

Two-CD set Price: \$20

Snowfighters Video

A comprehensive training video for use by snowfighters, whose job it is to keep traffic safely moving when snow and ice make that job very difficult. Explains basics of snow removal, equipment preparation and maintenance, salt application rates, salt vs. abrasives, fuel consumption, history and uses of salt, etc., in a very informative, interesting manner. Updated July 1999. **Price: \$20**

A Bas La Neige Video

French-language version of **Snowfighters** video.

Price: \$20



700 North Fairfax Street, Suite 600
Alexandria, Virginia 22314-2040

Telephone: (703) 549-4648

Fax: (703) 548-2194

Website: <http://www.saltinstitute.org>

Email: info@saltinstitute.org