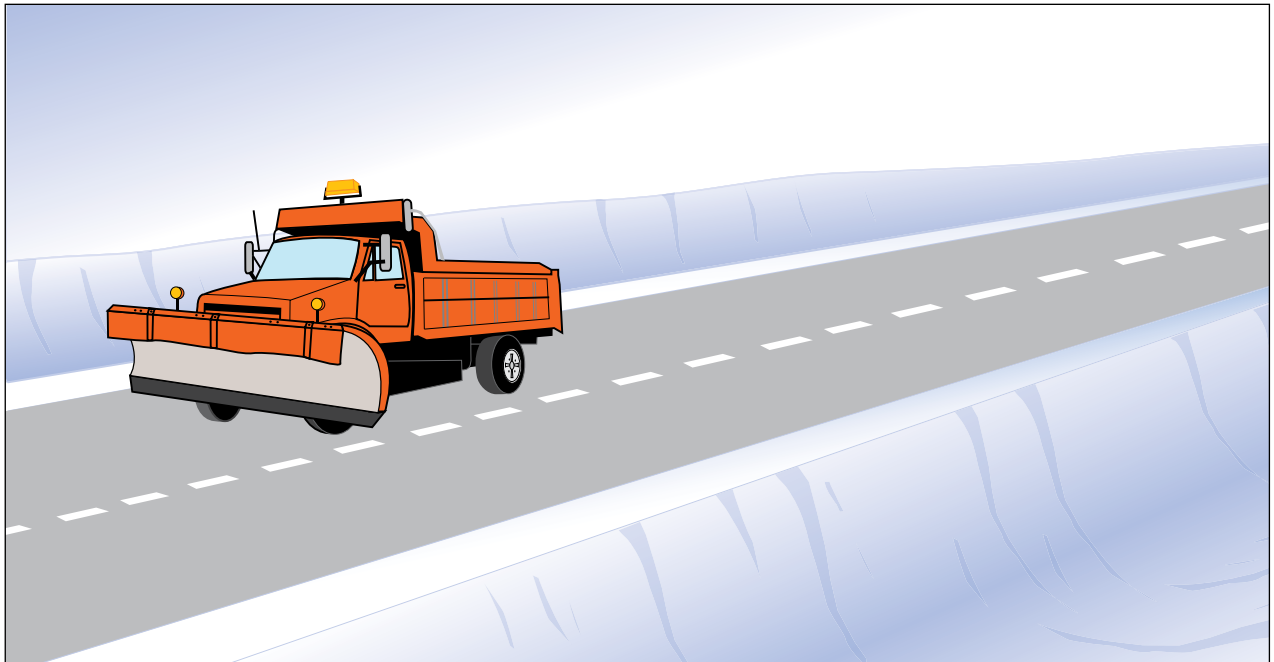


Chapter 7: Snow and Ice Control



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Safety Tips for Snow and Ice Control

Always check with your supervisor and follow your agency's safety policies and procedures.

Suggested personal safety gear

- Layers of clothes, extra gloves, heavy boots
- Shovel and ice scraper
- Flashlight for night operations
- Sunglasses for glare
- Water and/or hot liquid

Advance preparation

- Be properly trained and thoroughly familiar with all equipment and chemicals.
- Make sure an up-to-date first-aid kit, emergency contact information, and hand-held radios or cell phones are available in your vehicle.
- Be in good physical condition with adequate rest.
- Perform a pre-trip safety check of truck and equipment. Make sure the vehicle has adequate warning lights in good working order.
- Make a practice run of assigned route to check for obstacles and potential problem areas.
- Know the contact procedures for reporting crashes or equipment breakdowns.

During operations

- Dress in layers with heavy boots.
- Wear highly visible apparel when out of your vehicle.
- Plow at appropriate speed.
- Watch for pedestrians and other vehicles.
- Don't back up without a spotter.
- Operate wings carefully.
- Make sure warning lights are activated.

Today's motorists—and the needs of our economy—demand that roads be open and reasonably safe in almost any kind of weather. A road department's ability to remove snow efficiently and open roads quickly is often the standard by which the department is judged. Winter road maintenance is so important that many local governments size their entire road maintenance program—that is, the number of maintenance employees, the number and kind of vehicles, etc.—to accommodate winter maintenance activities. Snow and ice control is often a major budget item for many local governments.

Snow and ice control operations have two goals. First, make roadways passable. Second, provide adequate pavement friction to allow vehicles to brake, turn, and accelerate safely. This chapter discusses how road workers can help agencies meet these goals. Topics include preparing for winter operations, snow and ice control strategies, chemicals for anti-icing and deicing, enhancing friction, and post-storm activities.

Ten Commandments for Snow Fighters

1. Thou shalt present thyself to thy job physically and mentally fit and properly clothed for any emergency in order to withstand the rigors of thy task.
2. Thou shalt always inspect thy lights, windshield wipers, defrosters, flares, and other safety equipment before entering thy cab.
3. Thou shalt know thy spreading and plowing routes, as well as the performance of thy spinner and the life of thy plow blade.
4. Thou shalt faithfully remain alert in order to avoid guardrails, headers, stalled cars, manhole covers, railroad tracks, and mailboxes. Otherwise thee may smite thy windshield with thy head.
5. Thou shalt contain thy temper, even though cars and trucks pass thee on both sides and tailgate thee too close for comfort. Anger only multiplies thy prospects of coming to grief by accident.
6. Thou shalt use thy radio as briefly as possible—assuming thee is fortunate enough to have one. Remember thy fellow workers may need to communicate in an emergency.
7. Thou shalt interrupt the flow of power to thy spreader before attempting to free any foreign objects or blockage if thee treasures thy fingers.
8. Thou shalt render thy truck and spreader out of gear and stoutly set thy brakes before dismounting from thy cab.
9. Thou shalt govern thy speed according to conditions, else thee may wind up with thy truck upside down.
10. Thou shalt mind thy manners on the roadway, clearly signal thy intentions, and remember that it is more blessed to give than to receive.

[Adapted from the National Local Technical Assistance Program/Salt Institute. Source: Rural & Urban Roads, 1980]

Characteristics of Effective Snow and Ice Control

An effective snow and ice control program will have the following characteristics: Snow and ice are removed from (or prevented from reaching) roads, side streets, shoulders, and intersections in compliance with agency policies and procedures.

Preparing for Winter Operations

A detailed discussion of all pre-season preparations is beyond the scope of this book. The following sections provide guidelines for installing snow fences and for getting equipment ready.

Snow Fence

Preventing snow from drifting on or sticking to road surfaces is less expensive and time consuming (and safer for motorists and maintenance crews) than removing snow and ice from the road. Snow fences, both structural and “living,” slow snow-laden winds, causing the snow to drop and collect downwind from the fence. Properly located and installed snow fences significantly reduce the need to remove drifting snow and accumulated ice from the road. See figure 7-1.

Structural or living snow fences with about 50 percent of the total surface area open for the wind to blow through have the largest snow storage capacity. (Denser fences have shorter drift lengths, allowing for closer setbacks, but denser fences also have less storage capacity.)

The most effective snow fence height is generally 6–16 feet. (Fifty-percent porous, structural fences that are less than 6 feet tall typically do not provide enough snow storage capacity.)

Locate structural snow fence far enough from the road that the downwind drift does not extend onto the road. The optimum distance for a 50-percent porous, structural fence is normally 35 times the height of the fence. For example, a 6-foot fence would create a drift of approximately 210 feet.



Figure 7–1. Properly installed snow fences cause snow to collect downwind (WDM)

Ideally, install structural snow fence perpendicular to the general prevailing winds. Sometimes, however, depending on wind and roadway angles, snow fence will have to be installed parallel to the roadway.

Leave a gap under the structural fence equal to about 10 percent of the fence height to improve snow-trapping efficiency. Do not leave horizontal gaps in structural or living snow fence.

Extend the end of the fence past the roadway area that you want to protect from the wind. The optimum extension is approximately 20 times the height of the fence. This is necessary to accommodate variations in wind direction and because the wind wraps around the ends of the fence.

Living snow fences—rows of trees, tall shrubs, or corn left standing in the field—can also be very effective.

Appendix B illustrates proper installation of 50-percent porous, structural snow fence on flat terrain, as well as the proper configuration for a living snow fence of standing corn.

Prepare Equipment

Different models of spreading equipment vary in spreading rates, and different materials spread at different rates. Therefore, each spreader should be individually calibrated for the specific material that will be used. Refer to manufacturers' recommendations.

To keep all winter maintenance equipment in top condition, local agencies have regular maintenance routines.

Inspect Snow Plow Truck

Snow plow trucks are the key to successful winter maintenance operations. Keeping them in good working order is essential.

After every use, equipment operators should inspect their snow plow trucks and other equipment and report needed repairs. It is critical to pay attention to all of the parts of the truck as well as the equipment attached to it.

Conduct Pre-trip Checklist

A pre-trip checklist is required for commercial driver's license (CDL) compliance. Following the checklist will help prevent equipment failure and resulting accidents, injuries, and deaths.

Equipment Checklists

For a sample equipment checklist, see appendix C.

For a sample snow plow inspection checklist, see appendix D.

For a sample pre-trip checklist, see appendix E.

If your agency has its own checklists, use them instead. As always, consult your supervisor, and follow your agency's policies and procedures.

Snow and Ice Control Strategies

There are three general strategies for snow and ice removal/control:

- Anti-icing—applying chemicals to prevent snow and ice from bonding to pavement.
- Plowing—removing accumulated snow and ice from pavement.
- Deicing—applying chemicals to break the bond between snow/ice and pavement.

Generally speaking, anti-icing is used immediately before or at the beginning of a storm. Plowing is conducted when the storm is active or while the wind is still blowing. Deicing is conducted after the storm and when snow and ice are frozen solid to the roadway surface.

Which Strategy to Use?

Not all agencies use all three snow and ice control strategies. Many agencies use a flexible combination of these strategies before, during, and after each particular storm. For example, it is common to simultaneously plow snow and apply salt or other chemicals. Any of these strategies may be combined with application of abrasives (see Enhancing Friction later in this chapter). Consult your supervisor, and follow your agency's policies and procedures.

Knowledge of past storms, as well as accurate predictions about the timing, duration, and severity of imminent storms, helps maintenance supervisors make informed decisions about which strategies and materials to use, chemical application rates, and frequency of treatment.

Current and predicted pavement temperatures are the most important data for selecting appropriate snow and ice control strategies. The effectiveness of deicing chemicals is directly related to pavement temperature, not air temperature.

Importance of Forecasting

A winter maintenance program is only as good as your agency's ability to accurately predict the onset of a winter storm. It is critical to know when a storm will arrive and how air and pavement temperatures are changing along with wind direction and velocity. Accurate information about pavement temperatures is especially critical for selecting appropriate materials. Salt brine, for example, becomes less effective as the temperature approaches 18°F. (See Materials Selection, later in this chapter.)

For reliable forecasts tailored to your jurisdiction, Iowa's local agencies can access the Iowa DOT's extensive road weather information system (RWIS) network and value-added meteorological service. In addition, it is useful to establish a network of local contacts—maintenance supervisors in neighboring jurisdictions—who can provide real-time information about an approaching storm.

Anti-Icing

Anti-icing is a proactive approach to snow and ice control. It consists of applying liquid chemicals (usually salt brine) to pavement before, or at the very beginning of, a storm. The chemicals create a barrier layer that helps prevent snow and ice from bonding to the pavement surface. Accumulating snow can be easily removed by snow plows, leaving the pavement relatively dry. See figure 7-2.

Anti-icing chemicals will become diluted as snow turns into water and as accumulating snow is removed by plows. To offset the dilution and maintain the barrier, you may need to reapply chemicals during the storm.

Consider carefully before reapplying chemicals during the storm; the chemical may quickly become diluted and/or be plowed off the roadway. It is generally good practice to reapply during a storm after you've plowed/scraped the snow off and before the temperature starts to fall and the snow and ice begin to bond (freeze) to the pavement. (After the storm is over, you can switch to deicing to help clear the road surface if you are using chemicals that will be active at the forecasted temperature.)

Benefits and Cautions

Anti-icing has several benefits:

- Anti-icing often reduces total chemical use and may reduce costs related to materials, equipment, and time.
- Because pavement conditions are better when ice formation is prevented, anti-icing may provide more mobility and safer service.
- Anti-icing helps prevent frost formation on the pavement for some time following application, and post-storm cleanup is generally easier and faster.

Anti-icing may be less effective during periods of heavy, freezing rain, in blowing snow conditions, or in intense snowfall. If a storm gets ahead of anti-icing efforts, agencies generally switch to normal deicing strategies.



Figure 7-2. Urban anti-icing operations (WDM)

RULE OF THUMB

If snow is blowing across and off the road, consider carefully before applying anti-icing chemicals that may cause snow to stick to the roadway.

Anti-Icing Preparation Checklist

- Order chemicals and provide for proper chemical storage.
- Inventory equipment.
- Test/calibrate application equipment.
- Make sure communication channels are functioning. Establish inter-agency agreements. Share your plans with the media.
- Understand your agency's policies and procedures regarding level of service (LOS), peak traffic levels, and operations.
- Plan routes and conduct dry runs to identify trip length and time, obstacles, and trouble spots.

Anti-Icing Guidelines

1. Apply anti-icing material immediately before or just as a storm begins to prevent bonding of snow or ice to the pavement.
2. Use accurate pavement temperature and other road weather information to decide when to begin applying chemicals.
3. Anti-icing is often effective for heavy frosts. Early application of chemicals is important for frost or light freezing drizzle.
4. Apply with stream nozzles so the material is distributed directly on the vehicle wheel paths.
5. Schedule applications on selected sections of the roadway (e.g., bridge decks) if the temperature and conditions could produce frost or black ice.
6. Consider spot applications on hills, curves, and intersections.
7. Apply material during low-traffic periods if possible.
8. When frost on the shoulder begins moving into the traveled lanes, reapply chemicals.

RULE OF THUMB

The surface can re-freeze if precipitation or moisture on the pavement dilutes the chemical, or if temperatures drop below the effective temperature of the anti-icing chemicals.

Things Not to Do

1. Do not apply anti-icing chemicals with fan sprayers.
2. Do not apply chemicals when the wind is blowing hard enough to carry the material off the roadway. Be aware of areas that are sensitive to blowing chemicals.
3. Reapplication is not always necessary. Residual chemicals can remain on the roadway for several days.
4. Do not apply chemicals if the wind is blowing snow off the road.

Anti-Icing Training

The American Association of State Highway and Transportation Officials (AASHTO) has developed an interactive, self-directed training program to help road maintenance personnel understand and implement anti-icing effectively. The Anti-Icing/RWIS Training package is available to members of the National Association of County Engineers (NACE) free of charge. You can order your copy, through Iowa's Local Technical Assistance Program, 515-294-9481, hoganj@iastate.edu. Cities can borrow the Anti-Icing/RWIS Training package from Iowa LTAP.

Plowing

During and after a storm, use snow plows to clear roads as needed. See figure 7–3. Snow plowing is a challenge in both rural and urban areas. In rural areas operators must deal with blowing and drifting snow along with decreased visibility. In urban areas operators must deal with parked cars, narrow streets, and cul-de-sacs.

Timing/Scheduling

- Plow roads to remove snow and loose ice before applying deicing chemicals.
- Coordinate plowing activities with co-workers to avoid creating windrows at intersections and to prevent removal of another operator's applied materials.
- Keep your supervisor informed of changing road and weather conditions.

Techniques

- Remove snow from roads as quickly as possible to reduce compaction.
- Use underbody blades to help remove compacted snow or slushy snow.
- Use carbide edge inserts on snow plow blades to extend the life of the blades.
- Adjust the blade angle to maximize cutting efficiency or snow-throwing capabilities.
- Do not push or blow snow off a bridge into the water or onto traffic below.
- Know the height of your truck box, and raise the box only to move material to the back of the box.
- Avoid making sudden moves.
- Pace your speed to the general traffic's speed as much as possible.



Figure 7–3. Cleared road (WDM)

RULE OF THUMB

Many agencies have snow ordinances that describe when snow plowing will be conducted and designate snow routes. Consult your supervisor, and follow your agency's policy.

RULE OF THUMB

Minimize dilution of deicing chemicals by plowing immediately before applying the chemicals.

Cautions

- When plowing on a two-way road or street, stay on the proper side of the road.
- To avoid hitting obstacles, be aware of the width of your truck/equipment.
- Be aware of your surroundings, especially hazards like downed power poles, traffic signals, overhead structures, and power lines.
- Obey traffic laws and use your seat belt.
- Make sure your truck windows and lights are clean.
- Be courteous toward other drivers, bicyclists, and pedestrians.
- Be aware of your truck's changing braking abilities as the loaded box empties.

Avoiding Snow Clouds

Even a very light snow cloud behind your truck can temporarily reduce motorists' ability to see you (and your ability to see them) and increase your chances of being hit from behind.

Snow clouds can form during any plowing operation, but truck speed and wind contribute to clouds.

If you can, avoid plowing when it's windy. For example, if it is not essential to plow a shoulder immediately, postpone plowing until the wind has died down.

Equipment

Different equipment and configurations—snow plow trucks, V plows, tandem vehicles, wing plows, and snow blowers—can be used for snow removal, depending on storm conditions and severity. Following are common uses for various kinds of equipment:

V Plows: Deep Snow, Heavy Drifts

V plows are heavy and can move a lot of snow and punch through big drifts. See figure 7-4. To prevent getting stuck, however, the snow plow must travel at a slow forward speed. When using a V plow, start at the middle of the roadway and work your way toward the edges with additional passes.

Tandem Plows: Multi-Lane Facilities

When clearing a multi-lane facility, several snow plows working in tandem will remove snow more quickly. See figure 7-5.



Figure 7-4. V snow plow (WDM)



Figure 7-5. Tandem snow plow (WDM)

Wing Plow: Shoulders

After snow has been moved to the edge of the street or onto the shoulder, you can use a wing plow to move the snow further away from the roadway and reduce the potential for blowing snow to drift back onto the roadway. See figure 7-6. You can also use wing plows to clear snow from sidewalks or paths.

Snow Blower: Clean Up

In congested areas, use a snow blower to load snow into haul trucks for removal to a remote location. See figure 7-7.



Figure 7-6. Winging operations (WDM)



Figure 7-7. Snow blower (WDM)

Deicing

Deicing consists of applying chemicals to snow and ice to break their bond with the pavement. See figure 7–8.

If anti-icing strategies were not implemented before the storm, or if a storm “gets ahead” of anti-icing efforts, agencies may conduct deicing activities. Normally deicing is conducted when the temperature drops at the end of the storm activities and the snow/ice has bonded to the pavement.

Deicing chemicals work by lowering the freezing point of water. As the snow/ice turns to water, the deicing chemicals will become diluted and may need to be reapplied.



Figure 7–8. Urban application of deicing chemicals (WDM)

Chemicals for Anti-icing and Deicing

Common materials are sodium chloride or rock salt (NaCl) (dry, wet, or in solution, or brine), calcium chloride (CaCl_2), magnesium chloride (MgCl_2), and calcium magnesium acetate (CMA). Figure 7–9 shows the lowest temperatures at which these materials are generally effective. For applications rates, see your agency's procedures.

In Iowa, the most common deicing chemicals are salt and calcium chloride solutions. A salt solution or brine (23.3 percent concentration) freezes at 18°F ; a calcium chloride solution (29.8 percent concentration) freezes at -20°F .

Salt

Salt is the most common deicing material used in Iowa. In addition to being an effective deicing material, salt provides immediate anti-skid protection while starting the melting process.

To effectively melt snow and/or ice (and therefore prevent or break the bond with the pavement), salt must be dissolved in solution. If dry salt is applied to a pavement, the necessary moisture for dissolution must come from pavement surface moisture or from humidity in the air. If the pavement temperature is below freezing, dry salt rapidly loses its effectiveness because moisture on the pavement needed to make salt solution is already frozen.

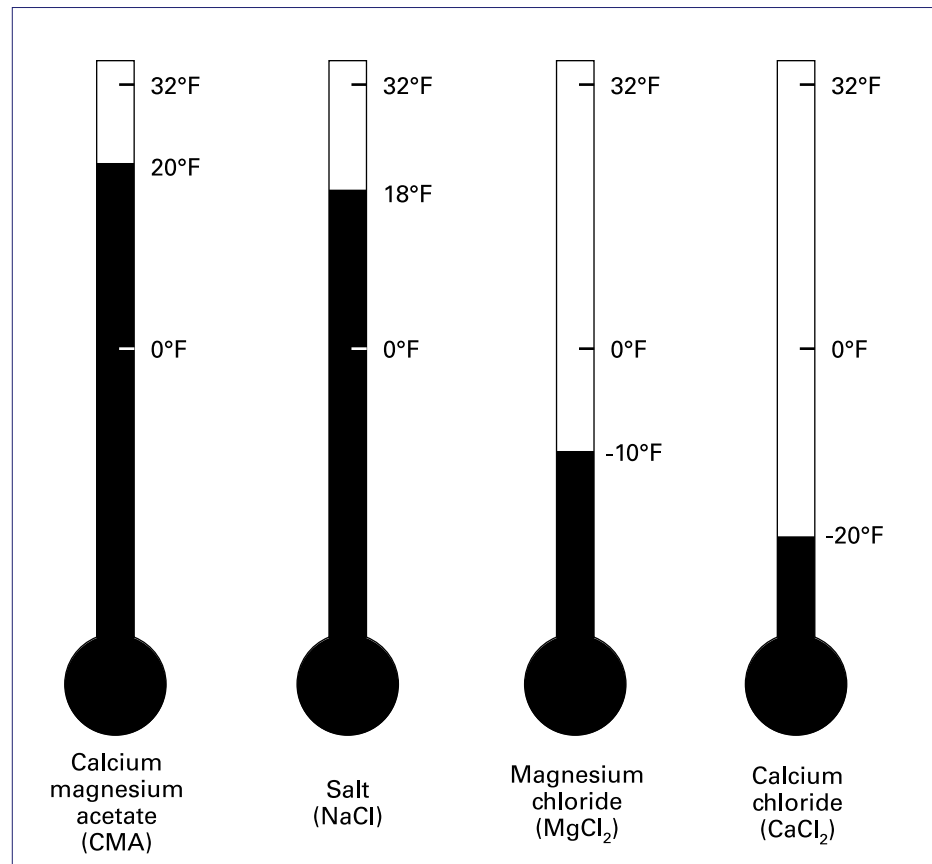


Figure 7–9. The lowest temperature at which different chemicals are effective

Guidelines for Applying Salt

- For deicing activities on two-lane pavements with low to medium traffic volumes, apply a windrow of salt in a strip along the centerline. Traffic will move salt off the centerline. The resulting salt brine will move down the pavement cross slope and toward the shoulders, melting snow and ice across the entire road width. With this application pattern, less salt is wasted (than with spinners, for example) and quickly gives vehicles clear pavement under at least two wheels.
- For deicing activities on multiple-lane pavements with medium to high traffic volumes, apply salt in a pattern that covers the full width of the roadway to provide melting action over the full width of the pavement.
- “Play the wind” when spreading salt. A strong wind blowing across a street or roadway can cause salt to drift as it comes out of the spreader, perhaps blowing salt onto the shoulder and into the ditch or into a street gutter. This is particularly true in rural areas where there are few wind breaks. How the wind affects spreading depends on both wind velocity and pavement condition. Use the wind to help distribute the salt where you want it.
- On super-elevated curves, apply salt to the high side of the curve so the brine will flow down and across the roadway.

Pre-Wetting Salt

Pre-wetting salt has become common practice. Wetting provides moisture to make brine, resulting in faster melting action. In addition, wet salt has less tendency to bounce off the road or to be blown off by traffic, saving 20 to 30 percent in wasted salt, which can more than pay for pre-wetting.

Common chemicals used for pre-wetting salt are liquid calcium chloride and salt brine:

- Liquid calcium chloride is used widely for pre-wetting salt because it draws moisture from the air and releases heat when it dissolves. Applications of 6 to 10 gallons per cubic yard of salt are recommended. Calcium chloride has the added advantage of melting snow/ice at lower temperatures.
- Using salt brine to pre-wet is becoming more common because of its lower cost. Some agencies are producing their own salt brine solution (23 percent). Liquid calcium magnesium acetate and magnesium chloride are also used.

Some agencies pre-wet the salt by spraying it as it is loaded into the truck. However, the application is more uniform if truck-mounted equipment is used to spray the salt as it leaves the spreader. This also eliminates the problem of handling pre-wetted salt that is not immediately used.

RULE OF THUMB

If snow is blowing across and off the road, let the wind help with snow removal. In these cases, be careful not to wet the pavement surface by adding chemicals that will cause snow to begin sticking and creating slick spots on the roadway.

Salt Brine

Salt brine is commonly used in Iowa for anti-icing activities. Salt brine is a mixture of approximately 23 percent rock salt and water.

Although commercial brine makers are available, many agencies manufacture their own brine makers with water tanks and PVC pipe. The brine can be stored in large tanks where it will be convenient for loading the material into saddle tanks on the sides of the V-box or anti-icing equipment.

Calcium Chloride

Calcium chloride is more expensive than salt and requires special handling. In addition, it tends to leave the pavement wet for a while, causing blowing snow to stick to the pavement. But calcium chloride is more effective in melting snow and ice at lower temperatures than salt and is faster acting. Calcium chloride draws moisture from the air and, when it dissolves, actually gives off heat. These unique properties make it valuable in severe conditions. Used strategically, usually in combination with salt, calcium chloride can be a useful and cost-effective deicing material.

Mixing even a small amount of calcium chloride with salt (see Pre-wetting Salt earlier in this chapter) can be very effective. The calcium chloride will start melting quickly, and the resulting brine and heat allow the salt to start working faster.

Store calcium chloride in moisture-proof bags until needed. Otherwise, its ability to draw moisture can cause it to cake into large chunks.

There are four methods of applying liquid calcium chloride:

1. Dispensed from a tank on the spreader at the same time the salt is spread on the road.
2. Applied to each loader-bucket of salt just before salt is placed in the spreader.
3. Applied to entire load of salt in the spreader.
4. Applied to entire salt stockpile before the winter season.

Enhancing Friction

Sand and other abrasives improve vehicle traction on snow and ice-covered roads. (Even dry or pre-wetted salt improves traction briefly after it is spread.) Abrasives can be used at all temperatures, but their use is especially important when it is too cold for chemical deicers to work. Since abrasives must stay on the surface to be effective, they should not be used when they will be covered with more snow or when they will be blown off quickly by traffic. Heavy traffic reduces the effectiveness of abrasives, requiring repeated application.

Sand is the most commonly used abrasive, but slag, cinders, and bottom ash from power plants are also used.

Sometimes deicing chemicals are mixed with sand. The sand gives immediate traction, and the chemicals melt the snow either immediately or when the temperature rises. However, to be effective the chemical must remain on the

pavement, which is difficult to achieve in most cases. Mixing salt with sand reduces the salt's melting effectiveness.

A minimum amount of salt (50 to 100 pounds of salt per cubic yard) must be mixed with abrasives to keep them unfrozen and usable. Pre-wetting sand with liquid deicing material is also effective. The chemical helps to anchor the sand into the ice surface, makes the sand easier to load from the stockpile, and causes the sand to spread more evenly from mechanical spreaders.

Keeping Records

During snow and ice control operations, equipment operators may be required to record their activities. Such records can serve two purposes: They help staff track and manage current operations, and they provide information to help supervisors and operators improve future operations.

The information to be reported on trip tickets will vary from agency to agency. Check with your supervisor. Sample information includes the following:

- Operator's name
- Vehicle ID
- Date(s) and duration of shift
- Description of roads treated
- Beginning and end times of each treatment cycle
- Treatment locations and time if not done on a prescribed cycle
- Type of treatment performed on each cycle or run
- Road and traffic conditions observed on each cycle or run
- Percentage of streets cleared, by classification
- Total personnel in the field
- Inventory of equipment and operational status
- Inventory of materials
- Number and extent of breakdowns, and future availability of equipment
- Accumulation of overtime
- Snow accumulation
- Planned operations

After the Storm

Conduct post-storm activities as soon as possible so you are ready for the next snowfall.

Material and Equipment

- Return unused materials to the stockpile.
- Wash trucks and clean equipment.
- Check all blades.
- Check skid shoes on wings for excessive wear.
- Look over all equipment and check for cracks in welds or any missing parts. Point out any problems to your shop mechanic.
- Do another walk around of the truck checking tires, lights, and wipers.

Sewer Drains

Clear drains so that melting snow and ice can move quickly off the road.

Snow Storage

Sometimes local agencies don't have room on or near the roadway to store the snow that has been plowed. This is fairly common in urban areas. To move the snow and completely clear traffic lanes and parking spaces, local agencies load the snow into trucks and haul it away to remote storage areas.

Storage areas may be on or near a lake or in remote open areas. They should be in locations that can handle the snow-melt runoff without overburdening existing drainage features and without violating Environmental Protection Agency requirements.

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