

TOWN of COPAKE

Updated:

January, 2019

SNOW AND ICE CONTROL

GENERAL INFORMATION

GUIDELINES

OPERATIONAL PROCEDURES

MATERIALS MANAGEMENT PLAN

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INTRODUCTION

I.A General

It is Town of Copake Highway Department's goal to provide a transportation system that is passable and reasonably safe as much of the time as possible within the limitations imposed by the natural environment, the availability of equipment, material and personnel resources. As a result of those limitations, it is recognized that there will be occasions when the pavement and bridge surfaces will be slippery and/or snow and ice covered. During these periods drivers must recognize the conditions and operate their vehicles in an appropriately safe manner. Priorities are established to provide the greatest benefit to the majority of the travelling public. In setting priorities, consideration is given to criteria such as, traffic volume, road classification, terrain, emergency services, drift exposure, and drainage problems.

This manual provides information and guidance to assist the Town of Copake Highway Department. It will serve as a basis for training Town of Copake Highway Department personnel.

The manual contains information on pre-winter operations and readiness, total storm management and decision making using Town of Copake Highway Department information resources, pre-storm preparedness, treatment options, post storm and post season activities. The provisions were developed to provide a reasonable balance among safety, cost, and environmental responsibility. The manual also contains related operational procedures and personnel procedures. The contents of this manual supersede all applicable prior manuals, directives and guidance relating to snow and ice control.

The contents of this manual reflect best practices as determined from a review of the relevant national and international literature and from information obtained from Town of Copake maintenance personnel through surveys and interviews. It is intended to be a "living document" that is responsive to new technology and techniques developed within Town of Copake and elsewhere. Suggestions for change may be submitted at any time to: Copake Highway Department, 230 Mt. View Rd. Copake, NY 12516

The words shall, must, should, recommended and may used in Section II of this manual have the following meanings:

shall and must	- a required course of action
should and recommended	- a recommended course of action
may	- an optional course of action

I.B Specific Information for Motorists, Residents and Property Owners

I.B.1 How Residents and Property Owners Can Help Assure the Safety and Efficiency of Town of Copake’s Snow and Ice Control Operations, and their own Snow Removal Operations

- Do not park on Town of Copake streets, especially during snow or ice events (they may be ticketed and towed).
- Do not place trash cans within 2 feet of the edge of pavement.
- Keep basketball devices at least 10 feet from the edge of pavement.
- Do not park cars in driveways within 10 feet of edge of pavement.
- Do not allow children to build and occupy “snow forts” and similar creations within 10 feet of the edge of pavement.
- Do not relocate snow from driveways and sidewalks into the paved street. This is in violation of New York State Highway law (Article 8, Section 214) and will cause a hazardous condition on the street.
- Fences should not be within 10 feet of the edge of pavement.
- Remove all non-permanent seasonal items from within 10 feet of edge of pavement.
- Trim trees so that branches do not extend beyond the back of the curb.
- Pile most of the snow from the driveway throat on the traffic downstream side. This will minimize visibility problems.
- Shovel or plow an area immediately upstream of your driveway throat to accommodate plowed snow from the street. This will lessen build-up in your driveway throat.
- Cooperate with the winter parking regulations that are in effect.

I.B.2 Private Driveways and Roads

Town of Copake Highway Department snow removal crews do not clear private roads, driveways or driveway entrances of accumulated snow.

I.B.3 Plow Trucks Having Plows Raised

A truck with a raised plow does not always mean the driver has completed your area. They may be:

1. Returning for fuel or vehicle service
2. Returning to the maintenance yard for additional treatment material
3. Responding to a call to assist Emergency Services, i.e.:
 - a) Police Department
 - b) Fire Department
 - c) Volunteer Ambulance
 - d) School District Transportation Department

I.B.4 Mailboxes, Mailbox Posts and other Features that may be damaged by Town of Copake Highway Department plowing operations

You can help reduce the possibility of a damaged/broken mailbox or mailbox post. Plow operators are urged to take precautions to avoid hitting mailbox posts. Experience has shown that reduced visibility during a storm makes it difficult for a driver to see a post in time to avoid striking it or pushing it over with plowed snow. .

Any installation within the right of way - including a mailbox/post - is placed there at the owner's risk.

Mailboxes and fences should be installed in accordance with the Highway Superintendent's recommendations respect to set backs and elevations. The Highway Department assumes no responsibility for mailboxes and fences damaged during the normal course of operations.

Owners are encouraged to install mailboxes at the maximum usable distance from the edge of the pavement. Posts should also be checked for deterioration to reduce the possibility that the weight of the plowed snow may simply break or push the post over. The Town of Copake Highway Department shall not repair or replace mailboxes or posts damaged by the force or placement of plowed snow.

PERSONAL/PRIVATE PROPERTY: The Right-of-way (ROW) is often 50 feet wide and is often confused by property owners as their own property. In most case, the ROW often extends 10 to 20 feet of either side of the paved or gravel road. Homeowners often cultivate extensions of their lawns, place mailboxes, erect fences or stone walls in these areas, which may improve the appearance of the street, but is obstructive to the snow removal operations. New York State Highway Law (Article 8, Section 214) prohibits people from placing ANY material on any highway, including snow and ice from their driveways and

sidewalks. The law also allows agencies to regulate mailbox structures and other items that may be considered to be an obstacle

Town of Copake Highway Department will not repair plow damage to grass and other plantings that are adjacent to the road

I.B.5 Contacting the Town of Copake Highway Department during a Snow or Ice Event

Avoid calling municipal offices during a storm except in an emergency. Personnel are extremely busy dealing with storm conditions.

Emergency calls during snow removal season should be placed to the Town of Copake Highway Department, (518)325-4222.

I.B.6 Emergency Information

American Red Cross Supported Town Emergency Shelter Plan:

Definition: A public facility equipped with a backup electrical power supply, food service and sanitary needs, capable of 24 hour housing for citizens to include the provision of meals, the provision of temporary lodging, and security.

Primary Shelter Designation: Copake Town Park Building, capacity: 295

Secondary Shelter Designation: Taconic Hills School Campus, capacity: 5,290

Shelter Area: Level 1

1 Town of Copake Park Building: 305 Mountain View Road

2 Copake Town Hall: 230 Mountain View Road

Level II Major Disasters

1 Taconic Hills High School: 73 County Route 11A, Craryville

Support

SUPERVISOR	Jeffrey Nayer	329-1234 ext. 1
HIGHWAY SUPERINTENDENT	William Gregory	325-4222

NYSEG		1-800-572-1131
	GAS	664-7823
	ELECTRIC	664-7823
TACONIC TELEPHONE		392-4414
TOWN CLERK		329-1234 ext. 2
COPAKE PARK BUILDING		329-4242

Columbia County Department of Social Services
(O) 828-9411 828-5041 Pager: 822-3488
American Red Cross 1-800-REDCROSS
Hospitals

Albany Med	262-3125
Albany Memorial	471-3111
Berkshire Med	413-447-2000
CMH ER	828-8500
Fairview Hospital	413-854-9700
Northern Dutchess	845-871-3440
Sharron Hospital	860-364-4111
St. Francis	845-431-8220

NYSDOT	828-9401
Columbia County Highway Department	828-7011

I.B.7 Priority of Treatment

Treatment priorities are found in Section II.B of this document

I.B.8 Winter Driving Safety Tips

AAA Offers Easy-To-Follow Winter Motoring Advice

Winter driving is tough on motorists and vehicles. To help drivers make it through the toughest winter conditions, AAA Southern New England offers the following tips:

Charge!! - Cold weather is tough on batteries. At zero degrees, a car's battery loses about 60 percent of its strength. At a comparatively mild 32 degrees, a battery is 35 percent weaker. Keeping battery terminals clean helps, but a load test performed by a qualified technician will help determine whether a car's battery is strong enough for winter starts.

Get a Grip - Before winter arrives, make sure your car is equipped with tires that are able to handle New England's winter weather. For most motorists, all-season tires are adequate. In more northern or mountainous regions, replacing your tires with four snow tires will help give your vehicle traction for slippery and snowy road conditions.

See and Be Seen - Danger must be seen to be avoided. Driving with a snow-covered windshield, windows, side-view mirrors or lights invites a crash. Clear windows, mirrors and lights with an ice scraper, brush or spray de-icer. Make certain windshield wipers and defrosters are in good working order and that washer reservoirs are filled with no-freeze windshield washer fluid.

Slippery When Wet - In temperatures at or just above 32 degrees, a thin layer of water can cover the ice, causing extremely slippery conditions. The distance needed to stop on ice at 32 degrees is twice as long as at zero degrees.

Keep Your Engine Cool - Make certain cooling system antifreeze is mixed with an equal portion of water for maximum protection.

Fast Solution - A squirt of de-icer spray is a quick method to overcome frozen door locks.

Air It Out - Don't let frigid temperatures tempt you into starting your car in a closed garage or idling your engine for long periods with the windows closed. Carbon monoxide, present in exhaust fumes, is almost impossible to detect and can be fatal when breathed in a confined area.

Finish Up - Road salt, slush and grime are especially hard on a car's finish. To help prevent rust and paint damage, keep cars washed and waxed. A full or self-service car wash makes the job easier when temperatures are low.

AAA Offers Winter Advice For Parents of Young Drivers

Winter driving can be challenging to any motorist, but slippery roads can be especially difficult for novice drivers dealing with ice and snow for the first time, according to AAA Southern New England.

"Parents need to work with their teens to help them gain the experience they need for safe winter driving in the safest possible environment," said John Paul, AAA Manager of Traffic Safety and Public Affairs.

AAA offers the following tips to help parents teach their teens to drive in winter conditions:

- Under close supervision, let your teen practice slow speed maneuvers on a wide open snow- or ice-covered parking lot. Have him or her practice hard braking and steering in skidding conditions.

- A novice driver's first on-the-road experience with winter-weather driving should not occur during a major snow storm. Wait until conditions are less severe.
- Consider limiting your teen's driving on slippery conditions to daylight hours until they have gained experience.
- Remind your teen that driving under the influence of drugs or alcohol is dangerous under any conditions, and that the risk is even greater on slippery roads.
- Make sure the vehicle your teen is driving is equipped with essential emergency equipment, including a flashlight, blankets, jumper cables, sand or non-clumping cat litter and a small shovel or ice scraper.
- SUV's can lead to over confidence on the roads. All vehicles should be driven cautiously in poor weather conditions.

AAA Recommends Emergency Equipment Kit

Because even the best maintained vehicles can fall victim to frigid winter weather, AAA recommends every vehicle carry the following items to ensure safe winter travel:

Flashlight - A working flashlight should be stored where the driver can access it without leaving the vehicle. That will enable the motorist to see obstacles and be seen by other drivers when exiting the vehicle in an emergency. Also carry spare batteries.

Jumper Cables - Jumper cables can be an essential tool for starting vehicles with weak or dead batteries, but they should only be used by individuals familiar with the proper safety precautions. Vehicle owner's manuals should be consulted for instructions.

Abrasive Material - Sand or non-clumping cat litter can be spread under the wheels to improve traction when a vehicle becomes stuck in snow or ice. Special traction mats and even floor mats also can be used for this purpose.

Shovel - A small shovel can be used to carefully dig snow away from the wheels.

Warning Devices - Flares or reflective triangles alert other motorists that you are broken down or stuck and helps give them enough time to slow down in order to pass safely. Safety Tip: When using flares/reflectors place them at least 100 feet from the rear of the car.

Safety Tip - Flares or reflective triangles alert other motorists that you are broken down or stuck and helps give them enough time to slow down in order to pass safely

Blankets - Cold weather can quickly turn an inconvenient breakdown into a life-threatening situation. Blankets can provide valuable protection against the cold and can help keep you comfortable until help arrives. Floor mats and newspapers can also be used to provide insulation in emergencies.

Snow Brush/Ice Scraper - It's important that windows and lights are clear of ice and snow in order to maintain adequate visibility. The entire vehicle should be brushed clear so blowing snow does not become a hazard for other motorists. Tip: If you drive an SUV or van a long handle brush will make quick work of clearing snow from the roof.

Cellular Phone - A cellular telephone comes in handy when a motorist needs assistance in the event of a vehicle breakdown.

Plan Ahead To Avoid Frustrating Travel This Holiday Season

To make the most of this holiday season, AAA Southern New England suggests planning ahead to avoid common holiday travel pitfalls.

"When you take a holiday, add the threat of bad weather and throw in 25 to 30 million motorists, you get a recipe for frustration," said Lloyd Albert, AAA Senior Vice President Public/Government Affairs and New Business Development. "With some advance planning, the season can be much more enjoyable."

AAA offers these tips for safe and happy holiday auto travel:

- Leave early, stay late. If possible, leave a day earlier than normal and return a day early or a day late. You can avoid wasting time in traffic and enjoy more time with family and friends.
- Plan ahead. Know your route and have an alternate plan in case of heavy traffic. Also make sure your vehicle is in top condition and carry a vehicle safety kit.
- Take your time. The current land speed record is 763 miles-per-hour. Don't try to break it on the way to grandmas. It's better to plan extra time and arrive safely.
- Take a 15- to 20-minute break every few hours. Stop at a safe rest area and stretch your legs. Also, drink plenty of fluids.
- Bring activities. Children's attention spans are shorter than adults, so they quickly lose interest when traveling. Pack some special snacks and favorite toys to keep them busy. Try a recorded story or sing-along tape.
- Don't eat and run. After the third helping, take a walk to get the blood flowing again.

Strong Battery Boosts Winter Car Starts

One of the best ways to protect against winter car trouble is to be certain your battery is fully charged and in proper working condition, according to AAA Southern New England.

"When the temperature drops to near zero, the number of calls AAA receives from stranded motorists soars," said AAA Approved Auto Repair Manager John Ward. "The most common cause of these cold-weather breakdowns is a weak or dead battery."

AAA recommends motorists have a load test to closely monitor the condition of the vehicle's battery, especially batteries more than two years old. "Although batteries can carry warranties of four years or more, a warranty is no guarantee an older battery will continue to work in severe weather," Mr. Ruggiero said.

The most common sign of a weak battery is an unusual sound coming from the starter motor when the ignition key is turned, indicating difficulty in starting the engine.

If the vehicle is difficult to start, check that the battery connections are tight and no corrosion is present on the battery terminal. To remove corrosion, use an old toothbrush to clean the cable connectors and terminals with a solution of baking soda and water. Next, inspect the tension of all drive belts. They should flex no more than 1/2 inch. If the battery's fluid level can be checked, make certain the fluid covers the battery plates. If no problems are found and the vehicle is still difficult to start, drive to a service station or auto parts store to have the battery and charging system tested and, if necessary, replaced.

In addition to weak or dead batteries, starting problems can be caused by malfunctioning alternators or starter motors. A qualified repair facility can make an accurate diagnosis and repair.

If the vehicle will not start, use caution and follow instructions in the owner's manual when attempting a jump start. If unsure about the proper procedure, call AAA or another qualified professional for assistance.

To help avoid winter breakdowns, AAA recommends motorists have their cars and trucks thoroughly inspected before cold weather arrives. In addition to the battery, fluids, belts, hoses, filters and tires should all be checked.

Because of the difficult driving conditions often encountered in the winter, motorists should also be sure their lighting systems, brakes and windshield wipers are functioning properly.

I.B.9 Disabled Vehicles

The Town of Copake Highway Crew will not tow private vehicles which are stuck in the snow or have run off the road. Plow truck operators may provide assistance, at the discretion of the operator, if a safety issue exists or road blockage occurs.

II. OPERATIONAL GUIDELINES

II.A Goal of Snow and Ice Control Operations

Town of Copake Highway Department will conduct snow and ice control activities that afford customers a reasonably safe and passable (not necessarily bare) road surfaces much of the time as possible. To accomplish that, snow and ice accumulations will be removed as soon as possible, consistent with stated priorities and resources. To the extent possible, the bond of snow and ice to the pavement will be prevented by the timely application of ice control chemicals (anti-icing strategy). Abrasives may be used as necessary to provide temporary friction improvement.

Certain conditions such as unavailability of equipment and personnel, blizzards, whiteouts, other locally severe snow, ice or wind events, thin ice formation in the absence of or during very light and spotty precipitation, and other conditions unknown to or beyond the control of Town of Copake Highway Department maintenance forces may temporarily preclude achieving this goal.

The objectives stated above will be achieved by implementation and execution of the procedures and tasks outlined in this policy. Due to the many variables that are inherent in the Northeast weather, each storm and/or weather event may require slightly different efforts and/or emphasis on any number of maintenance tasks, which, together determine the overall winter maintenance, snow removal or ice control strategy.

II.B Operational Priorities and Personnel Policies

II.B.1 Operating Priorities

The plowing operations will generally consist of three phases; making the roads passable, widening and treating the roads, then a general cleanup. The final widening pass is usually completed within 24 hours after the snow stops completely. This, of course, depends on the severity of the storm.

II.B.2 Personnel Policies

II.B.2.a Hours of Continuous Duty

It is our policy to start to conduct snow & ice control procedures at the beginning of a winter storm. Forecasts of extended storm events may influence snow and ice strategies. We will continue to plow and treat the roads as necessary in the judgment of the Highway Superintendent, provided that operations will ordinarily not be conducted earlier than 3:30 a.m. or later than 8:00 p.m. Monday thru Friday or earlier than 5:00 a.m. or later than 9:00 p.m. on Saturdays and Sundays. These guidelines must remain flexible due to

the infinitely variable nature of weather events, and must allow human judgment to be considered when making any decisions regarding the timing and selection of those roads needing plowing or sanding.

The Highway Department has only enough personnel for one shift of snow and ice removal daily. Note that in no case is 24 hour day coverage possible due to limited resources and operator safety concerns.

Once snow & ice control procedures are initiated, operations will be suspended if conditions deteriorate to the point that operations become unsafe for the employees of the Town of Copake Highway Department because of factors including, but not limited to: operator fatigue, severe cold, significant winds, limited visibility, accumulation of ice, or rapid accumulations of snow.

II.B.2.b Call-In Procedures

Drivers are required to report for duty within 30 minutes of notification

II.B.2.c Fitness for Duty

Drug and alcohol policy as outlined by the New York State CDL requirements and Town of Copake Highway Department Policy

II.B.2.d New York State Public Officers Law (Section 18)

Town of Copake will provide legal defense to employees for actions resulting from performing their official duties as long as the employee:

- Did not break a law
- Was acting within the scope of his or her official duties

II.B.2.e New York State Vehicle and Traffic Law (Section 1103)

Town of Copake Highway Department employees conducting snow and ice control operations should adhere to the provisions of the vehicle and traffic law. However, it is recognized that in order to satisfactorily perform required maintenance, some provisions of the vehicle and traffic law must be violated. Actions like clearing over highway center line and backing into traffic flow to clear intersections, and exceeding the maximum vehicle weight are necessary. Any necessary violations of the vehicle and traffic law must be performed “**with due regard for the safety of all persons**”. Some actions that fall into this category are slightly crossing the center line in order to completely plow the road, backing on a highway in order to properly clear intersections and exceed the maximum vehicle weight.

II.B.2.f New York State Insurance Law (Section 2335)

This law protects commercial and municipal drivers from having their personal insurance premiums impacted by accidents involving the employer’s equipment, unless the accident was intentional or caused by gross negligence.

II.B.2.g New York State Highway Law (Article 8, Section 214)

A section of this law prohibits any person from depositing any material on to any highway (including snow and ice from driveways). **There is a similar provision in the vehicle and traffic law.**

II.B.2h Town of Copake Local Law

No vehicles can be left in the Town ROW during a winter storm event. If a vehicle is left in the Town ROW and is obstructing the Highway Departments snow removal operations, a law enforcement agency will be contacted and if the owner is unable to remove the obstruction in a timely manner, the vehicle will be towed at the owners expense.

II.B.3 Operational Resources and Responsibilities

II.B.3.a Equipment

Vehicle #	Year	Make	Model	Estimated Replacement Cost
1	2016	GMC Pickup	F350	\$58,000
2	2004	Ford Pickup	F350	\$46,000
3	2013	GMC Pickup	3500	\$46,000
4	2001	International 6 wheeled dump	4700	\$120,000
5	2018	International 10 wheeled dump	7600	\$224,000
6	1999	International 10 wheeled dump	Paystar 5000	\$222,000

7	2011	International 10 wheeled dump	7600	\$222,000
8	2015	International 10 wheeled dump	Paystar 7600	\$222,000
9	2009	International 6 wheeled dump	4300 4x4	\$135,000
16	1998	International 6 wheeled 4x4 Plow	Paystar 5000 4x4	\$210,000
B-13	1996	Cat backhoe	416B	\$72,000
Excavator	2000	Cat wheeled excavator	M-312	\$155,000
Pelican	1992	Elgin Pelican road sweeper	Series SE	\$40,000
G-12	1986	Cat Grader	12G	\$210,000
L-10	2013	Cat Loader	938K	\$150,000
L-11	1999	Cat Loader	928G	\$150,000
M-14	2012	John Deere Tractor	6230	\$85,000
M-17	1999	Case Tractor	CX-90	\$50,000
Roller	1985	Hyster Roller		\$35,000
Toolcat	2017	Bobcat	Bobcat Toolcat	\$50,000
Grey Trailer	1986	Hudson	8,000lb	
Army Trailer	1968	Steve	5,000lb	
Blue Trailer	1987	International	17,000lb	
Black Trailer	1995	Starling	7,000lb	
Wood Chipper	1998	Vermeer	1230A	\$45,000

II.B.3.b Personnel Available

Copake Highway Department employees 7 full time employees and seasonal part time employees as needed.

II.B.3.c Budget Information

Materials Budget per Year: \$118,000
Snow and Ice Personnel Services: \$187,300.85

II.B.3.d Facilities Information

Highway Garage is located at: 47 School Road, Copake NY
Sand and Salt Building is located at the same address, capacity is 4200 square feet

II.B.3.e Snow and Ice Control Responsibility

Town of Copake maintains 53.48 miles of town roads

No winter maintenance will be conducted from December 1st to April 1st on Sunset Rock Road.

Town roads are identified with road names i.e.: Farm Rd., Yonderview Rd., and Birch Hill Rd. Town road signs are blade style (horizontal), have a green background and white letters.

The Town of Copake Highway Department does not maintain any County roads; County roads are identified with numbers or numbers and letters i.e.: 7 or 7A. County road signs are pentagonal in shape, have a blue background and yellow letters.

The Town of Copake Highway Department does not maintain any State roads; State roads are identified with numbers or numbers and letters i.e.: 23 or 9J. State road signs are square in shape, have a white and black background and black letters.

In addition to our 53.48 miles of Town roads we also plow and sand:

- Town Hall parking lot
- Town Park Building parking lots
- Municipal parking lot
- Copake Fire Co. parking lot
- Copake Fire Co. water sources
 - Folgers Pond
 - Town Pond behind Peck's Insurance Co.
 - Langdon's Pond across from Fire House
- West Copake Fire House Building

Salt the Craryville Fire House parking lot as needed

Sidewalk snow & ice control procedures will be conducted on the following sidewalks: between the intersections of Farm Road and County Route 7A, on the North side of County Route 7A (Church St.) and the pedestrian path along the property line of the Town Hall. Sidewalk snow clearance will be conducted as soon as possible, subject to availability of personnel. The need to maintain safe roadways will take priority. Property owners may assist the Town in sidewalk safety by clearing snow from sidewalks in front of their properties, provided that the snow so removed is not placed in the streets.

II.B.4 Operators Direct Communication with the Public

Operators are to report all stranded or stuck vehicles to the Highway Superintendents office. Operators may stop to check to see if the vehicles passengers are safe.

If an Operator is being flagged down to stop by a resident, the Operator may stop; however, the Operator should offer that all disputes or concerns be directed to the Highway Superintendents office. All Operators should have a business card of the Highway Superintendent to hand to the resident.

II.C Pre-Winter Planning Activities

II.C.1 Review and revise this manual as necessary

As this is a living document, appropriate changes should be incorporated as soon as possible. Areas that may change include: highway responsibility, technology, procedures, equipment, personnel, staffing, materials and level of service. Sources of changes may include: our customers, individual or work group suggestions, personnel meetings, post-season reviews and Town of Copake Highway Department Superintendent.

Levels of service goals should be reviewed for their impact on plow routes and required resources (personnel, equipment, materials, facility, etc.). Those resources should be assigned as necessary.

II.C.2 Review Emergency and Severe Weather Response Procedures

Town of Copake Highway Department road closure and reopening procedures should also be reviewed with all personnel likely to be involved. Procedures for re-deploying resources should be reviewed and coordinated within and among work areas. Other procedures that should be reviewed include chain control, internal and external communications, and command and control. Any emergency contracts and cooperative

and resource arrangements between the Town of Copake Highway Department and other local governments, NYSDOT, and all levels of applicable emergency management should also be reviewed.

II.C.3 Equipment Readiness

All of Town of Copake Highway Department's snow and ice control related equipment shall be inspected, test run, repaired as necessary, and receive scheduled maintenance prior to the snow and ice season.

II.C.3.a Truck Readiness

The prescribed seasonal and use based maintenance service shall be completed prior to the winter season. All trucks shall be checked with full winter gear (plows and spreaders) well in advance of the first anticipated snow or ice event.

II.C.3.b Material Spreader Readiness

The materials spreaders shall receive required maintenance and be lubricated, repaired, test run and calibrated. All ground speed controlled materials spreaders shall have a backup or manual calibration that can be used if the automatic system fails.

II.C.3.c Liquid Materials Dispensing Systems

Town of Copake Highway Department uses some liquid dispensing systems during snow and ice control operations. These systems shall be inspected, test run, calibrated, lubricated and repaired as necessary. Associated bulk storage tanks shall be inspected per manufacturer's recommendations. Appropriate safety gear (goggles, rubber gloves, etc.) and MSDS sheets shall be conveniently available. Any time a liquid is added to a tank be sure it is compatible with the liquid that is in the tank. When changing liquids in a tank, it is advisable to flush the tank before refilling with a different material.

II.C.3.d Plow Equipment

Plow equipment shall be inventoried, test mounted, and inspected for proper function, missing parts, structural damage, proper adjustment, and sufficient remaining wear depth on items like shoes and cutting edges. Necessary repairs and replacement shall be made. Plows shall be stored in a position for easy hookup and have easy-to-read identification to match them to the proper truck.

II.C.3.e Spare Parts

The maximum allowable stock of commonly used spare parts shall be acquired prior to the snow and ice season. These include: cutting edges, plow shoes, shear pins, nuts and bolts, filters, bulbs, spreader controller parts and truck springs. Windshield wipers should be new or near new at the start of the winter maintenance season.

II.C.3.f Individual Tools and Safety Gear

Trucks shall be checked for the required compliment of tools and safety gear. These include, for example: shovels, bars, hand tools, tire chains, flashlights, flags, flares, warning devices, gloves, hard hats, tow chains, ice scrapers, and snow brushes/brooms. Proper stowage for these and other in – cab loose items must be provided.

II.C.4 Personnel Readiness

II.C.4.a Acquisition and Assignment

Sufficient personnel (permanent, temporary, reassigned and interdepartmental) shall be acquired and trained for snow and ice operations prior to the winter season.

II.C.4.b Callout

The Town of Copake Highway Department has a policy that, during the Snow Season (mid-November to April 1), its employees consider their employment with the Town their primary job. The employees will be available for any snow emergency, i.e. all nights, weekends and holidays. The employees will also be available for any emergency that occurs during the year. Any employee not so available shall notify the Superintendent of Highways and shall set forth a valid reason.

II.C.4.c Training

Snow and ice control training shall be accomplished prior to the snow and ice control season. Training topics include, at a minimum: Town of Copake Highway Department communication, cooperation and responsibilities; weather conditions, road conditions, road and weather information systems; safety issues; public relations/information issues; operational issues and procedures; level of service (local and system-wide); equipment readiness; materials management; new technology, new initiatives and procedures; and emergency response issues.

II.C.5 Materials Readiness

II.C.5.a Contracts

Town of Copake Highway Department acquires most snow and ice control materials through the contract process. Given the time required to establish a contract, these requirements and contracts and purchase requisitions shall be done early. Typical materials purchased include sodium chloride (salt or rock salt), calcium chloride (liquid and flake), abrasives (sand), liquid magnesium chloride with corrosion inhibitor, etc.

II.C.5.b Materials Storage Structure

Most of the Town of Copake Highway Department snow and ice control chemicals are stored in a structure. This structure shall be inspected and repaired as necessary. It should be filled to working capacity prior to the snow and ice season.

II.C.6 Emergency Readiness

Staff likely to be involved shall review relevant portions of this document. Cooperative agreements within and outside of the Town of Copake Highway Department shall be reviewed and reaffirmed with the cooperating groups.

II.C.7 Highway System Readiness

Various elements of Town of Copake Highway Department's highway system shall be checked and given necessary attention as required. These include: permanent pothole repair, striping, drainage clearing and marking, winter signage, obstacle markers and delineators

II.C.8 Maintenance Facility Readiness

Certain features of Town of Copake Highway Department's maintenance facilities shall be inspected and repaired as necessary prior to the snow and ice season. These include: buildings, yard traffic areas, fuel delivery systems, yard and garage lighting, and emergency generators.

II.C.9 Road and Weather Information System Readiness

Town of Copake Highway Department has acquired a variety of systems and measuring devices to help in defining road and weather conditions. These include truck mounted pavement temperature measuring devices, NOAA weather band radios, and internet weather forecast providers. These systems shall be checked for function prior to the snow and ice season. All measurement devices and sensors shall be calibrated and maintained per the manufacturer's recommendations. All computers, software and communication systems shall also be checked and repaired as necessary.

II.C.10 Public and Customer Readiness

Town of Copake Highway Department employees are to be as courteous and helpful to public inquiries as possible.

II.C.11. Communication Systems

Town of Copake Highway Department has a variety of communications systems including: radio, cell phone, and land line phone and fax. These systems shall be checked prior to winter and any necessary training/retraining provided.

II.D. Decision Making for Snow and Ice Control Operations

As Town of Copake Highway Department acquires more information resources, it will be moving toward routine information-based decision making for determining appropriate snow and ice control treatments. That process involves the following:

- Gathering all available relevant information about recent past, present and near-term future conditions.
- Selecting a treatment option that best addresses those conditions.
- Systematically gathering and evaluating data on treatment effectiveness, actual road conditions, and actual weather conditions from operators and other sources.

II.D.1 Elements of Snow and Ice Control Decision Making

II.D.1.a Status of Assets

Assets for snow and ice control operations include personnel, equipment, information systems and materials inventories. Deficiencies in any of these areas will impact treatment decisions. Loss of truck availability due to mechanical failures or accidents will have an impact on response time and general snow removal operations. Every effort will be made to cover the route(s) by redistribution of resources.

II.D.1.b Weather Information

II.D.1.b.1 Weather Forecasts

There are a variety of weather forecast products available to Town of Copake Highway Department's maintenance forces. Decision-makers should be simultaneously evaluating short-term, mid-term, and long-term forecasts. Information on precipitation should include onset, cessation, type and intensity. Other relevant factors include air temperature, dew point, wind speed, wind direction, and cloud cover.

II.D.1.b.2 Current Weather Data and Observations

Current weather data and observations may be obtained from maintenance patrols, operators, police agencies, and media outlets.

II.D.1.b.3 Other Weather Information

Other weather data sources include radar and satellite imagery (Internet and local TV), NOAA radio, The Weather Channel; computer acquired current condition data from upstream storm locations, local TV and radio, etc.

II.D.1.c Highway and Pavement Information

II.D.1.c.1 Pavement Temperature

Pavement temperature is one of the most important factors when deciding on a snow and ice control treatment. Data on recent past, current and predicted pavement temperature is very useful. This data may be obtained from truck mounted sensors. Predictions and estimates can be made based on forecast knowledge of air temperature, ground temperature, cloud cover, precipitation, wind, and time of day.

II.D.1.c.2 Accumulations of Snow and Ice on the Pavement

Knowledge of the character and depth of any snow or ice accumulation on the pavement surface prior to treatment is important in the treatment decision process. Relative slipperiness and whether or not the snow or ice is bonded to the pavement are even more important.

II.D.1.c.3 Traffic Characteristics

Traffic data is important to the decision-maker. Relevant characteristics include volume, speed, timing of peak flow, status of any closures and any reduction in available lanes.

II.D.1.c.4 Status of Critical Locations

Traffic flow and pavement condition information for “critical” locations are important in prioritizing snow and ice control operations. “Critical” areas include hills, intersections, bridges, cold locations (low, shaded and elevated), locations having mist or fog generation tendencies, traffic generators, high snow and ice accident locations, school bus routes, and access to the municipal center, fire station, and ambulance service.

II.D.1.d Assessments of Effectiveness and Efficiency

Systematic after-action assessments of effectiveness and efficiency are important in the decision-making process as they provide a knowledge base for future decisions. Results achieved in response to treatment can be obtained from the reports of operators and crew

leaders. Other factors to evaluate include cycle times achieved, materials used, equipment performance, and cooperative procedures.

II.E Snow Control

II.E.1 General

For the purpose of this manual snow and ice control operations are separated into two Categories – snow control and ice control. Snow control is the mechanical removal of accumulations of “loose” snow from the paved and stabilized portions of the system. This is accomplished primarily with truck-mounted plows. In certain circumstances like cleanup and drift removal, front-end loaders, and motor graders are sometimes used. It may also involve the use of passive measures like snow fence and plantings.

Ice control is all treatment operations directed toward preventing snow or ice from bonding to the pavement and the chemical and or mechanical removal of bonded snow or ice from the pavement. It also includes providing temporary friction improvement by spreading abrasives and abrasives/chemical mixtures and using no-treatment when appropriate.

Snow control is one of the most difficult and important tasks assigned to Town of Copake Highway Department maintenance personnel. Having uniform snow control methods is important for the safety of our customers and our maintenance personnel.

There are some definitions relating to snow control that will help clarify subsequent sections of this manual:

Snow plowing	the relatively rapid displacement of snow from paved surfaces with vehicle-mounted plows and wing plows.
Snow removal	physically relocating areas of accumulated snow. This is usually a slow operation that may be accomplished with plows, loaders, or snow blowers.
Berm or windrow	an accumulation of snow cast by plow or other equipment.
Tandem plowing	snow plows working together to clear wider areas.

There are some general guidelines for keeping snowplowing operations reasonably uniform on Town of Copake Highway Department system:

- To the extent possible, traffic should not have to pass through a berm of plowed snow.
- All plowing shall be done with trucks moving in the direction of traffic, except in an emergency situations where the work area is closed to traffic or, backing in the direction of traffic is required to spread material on very slippery surfaces where normal directional travel will not provide sufficient traction for the truck to move and as necessary in the cul-de-sacs.
- To the extent possible, plow snow beyond the point where it could melt and run back across the highway. Snow may be cast toward the center of the cul-de-sacs even though it may be higher than the outside.
- Plowed snow shall not be cast into traffic.
- Cast snow downwind to the extent possible.
- In the cul-de-sacs, cast snow away from the driveways to the extent possible. This is less demanding on the property owners and facilitates more efficient general route plowing
- Within the normal sequences of operations, any time there is enough snow on the road to plow, it should be plowed.
- In events where snow is likely to change to freezing rain before ending, consideration should be given to leaving enough unplowed snow on the road to absorb the freezing rain. Plow and treat the road again after the event has ended.
- At the end of the storm, push snow back as much as possible to make room for the next snow storm.

Occasionally snowfall intensity is so severe that operator visibility is reduced to a few feet. With supervisor approval, operators may drive their trucks to a safe haven that is stable and well off the highway, shut their lights off and wait until visibility improves before continuing.

When low visibility is anticipated, extra caution in operations should be exercised. Vehicles and other obstacles may be anywhere. Supervisors should be prepared to suspend operations and recommend road closure if conditions warrant, or recommend temporary road closure so that plowing can be completed.

II.E.2 Safety Restoration and Cleanup Operations (Snow Removal)

After the entire Town of Copake Highway Department maintained highway system is in satisfactory condition, safety restoration and cleanup operations shall begin and continue until complete or operations are directed to higher priority snow and ice control or emergency work. This work will generally be performed on a “regular time” basis. Coordination of this work with interfacing agencies and other Town of Copake Highway Department units is recommended. Cleanup operations that may impact traffic flow or larger numbers of customers should be performed in lower volume time periods if possible and utilize traffic protection where appropriate. The following is a listing in priority order of the areas where snow should be removed:

- Locations that could melt and run onto traveled areas, For example: banked curves and sloped bridge decks.
- Snow stored on bridge decks. (Do not throw snow over the side of the bridges – transport it beyond the back wall and off the shoulder.)
- Areas having reduced sight distances for customers and plow operators, such as sharp curves and intersections.
- Buried or obscured regulatory and warning signs, delineators, and accumulated snow around work zone delineation.
- Any area where accumulated snow is causing traffic to use other-than-intended pavement areas.
- Any narrow raised features between the outside edges of pavement that may be storing snow.
- Commercial, business and residential areas where street parking is required to maintain mobility

II.E.3 Drainage Restoration

After safety restoration and cleanup operations are complete, drainage facilities should be inspected and cleared as necessary

II.F Ice Control

Ice control is all treatment operations directed toward preventing snow and ice from bonding to the pavement and the chemical and/or mechanical removal of bonded snow or ice from the pavement. It also includes providing temporary friction improvement by spreading abrasives

(sand) and abrasives/chemical mixtures, and using delayed or no-treatment options when appropriate.

II.F.1 Ice Control Strategies

There are four basic ice control strategies used by Town of Copake Highway Department – anti-icing, de-icing, temporary friction improvement, and delay of or no treatment. When conditions are favorable for success and resources permit, anti-icing shall be the strategy of choice.

II.F.1.a Anti-icing

Anti-icing is a modern strategy that takes an information-based systematic approach to preventing snow/ice pavement bond. This results in higher levels of service for longer periods of time. The key to effective anti-icing is to get an appropriate quantity of ice control chemical on the pavement surface before or very soon after precipitation or ice formation begins. This strategy is not appropriate for unpaved roads.

II.F.1.b De-Icing

De-icing is a traditional strategy for dealing with snow or ice that has already bonded to the pavement surface. It is used when anti-icing treatments have failed, as they occasionally will, or as a series of treatments at the end or after a storm. De-icing is most effectively accomplished by spreading a coarse-graded solid or pre-wet solid ice control chemical on the surface of the bonded snow or ice during favorable road, weather and traffic conditions. The coarse particles will melt through the snow and ice and break the bond as created chemical solution flows across the pavement surface. This strategy is not suitable for unpaved roads.

II.F.1.c Temporary Friction Improvement (Sand and Sand/Salt Mixes)

Temporary friction improvement is an immediate short-term improvement in surface friction that is achieved by spreading abrasives (sand) or abrasives/chemical mixtures on the snow or ice surface. There will be times when this is an appropriate strategy – usually in very cold conditions. A major disadvantage of this strategy is that its effectiveness degrades very quickly with traffic. If sufficient ice control chemical is spread with abrasives, it can be part of anti-icing and de-icing strategies. However, the effectiveness of ice control chemicals are significantly reduced by the sand.

II.F.1.d Delayed or Non-Treatment

Delaying or not applying ice control materials is a tactic that may be used in support of the anti-icing strategy. Conditions where this tactic should be considered include light precipitation events, where pavement temperature is likely to remain above freezing, and dry snow and blowing snow events where pavement surface temperature is below about 10° F and there is no residual ice control chemical on the pavement.

II.F.2 Terms Relating to Precipitation, Road Conditions, Ice Control Chemicals, and Operational Procedures

II.F.2.a Precipitation Terms:

Light Rain	small liquid droplets falling at a rate such that individual drops are easily detectable splashing from a wet surface. Include drizzle in this category
Moderate Rain	liquid drops falling are not clearly identifiable and spray from the falling drops is observable just above pavement or other hard surfaces
Heavy Rain	rain seemingly falls in sheets; individual drops are not identifiable; heavy spray from falling rain can be observed several inches over hard surfaces
Freezing Rain	when rain freezes upon impact and forms a glaze on the pavement or other exposed surfaces
Sleet (Ice Pellets)	precipitation of transparent or translucent pellets of ice, that are round or irregular in shape
Light Sleet	scattered pellets that do not completely cover an exposed surface regardless of duration. Visibility is not affected.
Moderate Sleet	slow accumulation on ground Visibility is reduced by ice pellets to less than 7 miles.
Heavy Sleet	rapid accumulation on ground Visibility is reduced by ice pellets to less than 3 miles.
Light Snow	snow alone is falling and the visibility is greater than ½ mile.
Moderate Snow	snow alone is falling and the visibility is greater than ¼ mile but less than or equal to ½ mile.
Heavy Snow	snow alone is falling and the visibility is less than or equal to ¼ mile.

Blowing Snow when fallen snow is raised by the wind to a height of 6 feet or more and is transported across a road

None no precipitation or blowing snow

II.F.2.b Road Condition Terms

Dry no wetting on the pavement surface

Damp light coating of moisture on the pavement resulting in slight darkening of surface, but with no visible water drops

Wet road surface saturated with water from rain or melt-water, whether or not resulting in puddles or run-off

Slush accumulation of snow on the pavement that is saturated with water. It will not support any weight when stepped or driven on but will “squish” until the base support is reached

Loose Snow unconsolidated snow that can be blown by the wind into drifts or off of a surface, or blown by traffic into non-traffic areas or off of a surface.

Packed Snow snow-pack or pack that results from compaction of wet snow by traffic or by alternate surface melting and re-freezing of the water

Frost also called hoarfrost. Ice crystals in the form of white scales, needles, feathers, or fans deposited on pavement and other surfaces cooled by radiation or by other processes

Thin Ice a very thin coating of clear, bubble-free, homogeneous ice which forms on a pavement; sometimes called black ice

Thick Ice a coating of ice thicker than black ice or frost that is formed from freezing rain, or from freezing of ponded water or poorly drained melt-water. It may be clear or milky in appearance, and generally is smooth though it sometimes may be somewhat rough.

II.F.2.c Ice Control Chemical Terms

Form the physical state of the chemical – usually solid or liquid

Gradation a characterization the distribution of particle sizes for solid chemicals and abrasives – i.e., fine, coarse, percent passing various sieve sizes, etc.

Concentration	the percent (by weight) of the ice control chemical in the liquid or solid product
Solution	a liquid containing chemicals and water
Eutectic Temperature	the lowest temperature a concentrated (near saturated) solution begins to freeze or the lowest temperature it will melt ice
Eutectic Concentration	the solution concentration that produces the eutectic temperature
Dilution	reducing solution concentration by adding water
Endothermic	becomes colder when going into solution
Exothermic	becomes warmer when going into solution
Hygroscopic	having the ability to draw water vapor from the air

II.F.2.d Operational Procedure Terms

Pre-treating	applying an ice control chemical (liquid or solid) to the road before a snow or ice event begins
Pre-wetting	adding liquid ice control chemical or water to solid ice control chemicals or abrasives prior to distribution on the road
Application Rate	the amount (weight or volume) of ice control chemical applied per mile or lane-mile of highway. In the case of pre-wetting liquids, it is the number of gallons of liquid applied to a ton of solid ice control chemical, or abrasives.

II.F.3 Ice Control Chemicals

Town of Copake Highway Department uses salt (sodium chloride or rock salt) as the primary ice control chemical. Other chemical will be evaluated if they show promise for improving efficiency, effectiveness and environmental friendliness.

The important properties of ice control chemicals include the lowest (eutectic) temperature it will melt ice, how much ice will be melted at various temperatures and the relationship between solution concentration and freezing point. The lowest (eutectic) ice melting temperatures appear in Table 2 and Figure 1. How much ice melted per unit of common chloride chemicals, at various temperatures, appears in Table 3.

The temperatures above are pavement surface temperatures. Other chemicals have similar relationships where their effectiveness decreases with decreasing pavement temperature. The importance of pavement temperature in ice control operations should be obvious.

The relationship (phase diagram) between solution concentration and freezing point is found in Figure I for sodium chloride, magnesium chloride, and calcium chloride. The low point on each diagram is the lowest temperature at which the chemical will melt ice (eutectic temperature). Any value falling below any point on the curves will be frozen. This includes solution concentrations greater than those producing the eutectic or lowest melting temperature on the diagrams.

The hygroscopic properties of the common solid ice control chemicals are:

- Sodium Chloride - slight
- Magnesium Chloride - moderate
- Calcium Chloride - high

Table 2. Ice Control Chemical Comparison

CHEMICAL		TEMPERATURE, F		CORROSION POTENTIAL		CONCRETE DAMAGE POTENTIAL	HANDLING CONCERNS	ENVIRONMENTAL CONCERNS
Formula Name	Form	Effective to *	Eutectic	Vehicles	Structure			
NaCl (Road Salt)	Solid	15	-6	Yes	Yes	Some **	Dust	Water, Plants
NaCl (Road Salt)	Liquid	23	-6	Yes	Yes	Some **	Dust	Water, Plants
MgCl ₂ (Magnesium Chloride)	Solid	0	-28	Low	Possible	Very Little	Dust	Water
MgCl ₂ (Magnesium Chloride)	Liquid	10	-28	Low	Possible	Very Little	Dust	Water
CaCl ₂ (Calcium Chloride)	Solid	-20	-60	Yes	Yes	Yes **	Generates Heat;Dries Skin and Leather	Water
CaCl ₂ (Calcium Chloride)	Liquid	0	-60	Yes	Yes	Yes **	Generates Heat;Dries Skin and Leather	Water
Organic Chemicals	Liquid			No	No	No	None	BOD in Water

* Pavement Surface Temperature

** If concrete is non-air entrained or has utilized poor materials or procedures

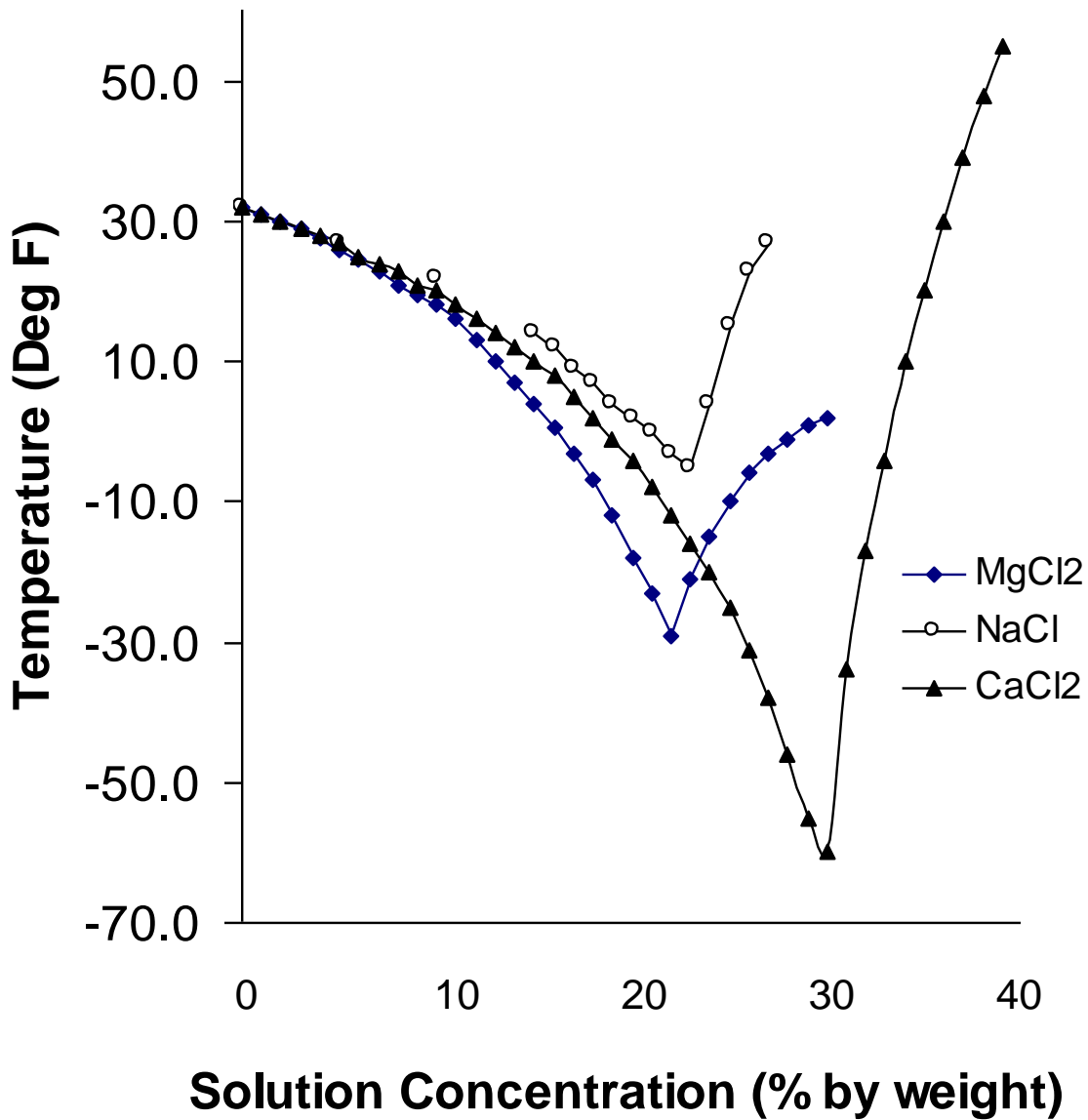


Figure 1. Phase Diagram for Ice Control Chemicals. Values plotted are not precise and are shown for illustrative purposes. These values have been estimated from the phase diagram shown in the FHWA *Manual of Practice for an Effective Anti-icing Program*.

Table 3. MELTING ABILITY AND TEMPERATURE FOR CHLORIDE CHEMICALS

Temperature		Units of Ice Melted Per Unit of Chloride Chemical		
°F	°C	Calcium	Magnesium	Sodium
30	-1.1	31.1	47.8	46.3
25	-3.9	10.4	15.4	14.4
20	-6.7	6.8	10.0	8.6
15	-9.4	5.5	7.9	6.3
10	-12.2	4.8	6.8	4.9
5	-15.0	4.4	6.1	4.1
0	-17.8	4.0	5.5	3.7
-6	-21.1	3.7	5.0	3.2

This means that solid calcium chloride and solid magnesium chloride should be protected with airtight coverings during storage.

The temperature increase or decrease when water is added to common solid ice control chemicals is:

- Sodium Chloride - slight decrease (endothermic)
- Magnesium Chloride - slight increase (exothermic)
- Calcium Chloride - large increase (exothermic)

Caution must be exercised when adding water to solid calcium chloride.

II.F.4 Pre-Wetting Ice Control Materials

Pre-wetting is the addition of a liquid to a solid ice control chemical or abrasives prior to distribution on the highway. The liquid application rate typically ranges from 8 to 12 gallons of liquid per ton of solid ice control chemical, depending on the efficiency of the pre-wetting technique and the gradation of the solid chemical. The benefits of this procedure include:

- Improving the retention of the materials on the road or ice surface.
- Accelerating the melting action of the solid ice control chemical
- Allowing the solid ice control to work better on lower pavement temperatures

Improved effectiveness should yield an overall reduction in solid ice control chemical use.

Any liquid as long as it is mostly water and will not freeze during operations is suitable for pre-wetting. Town of Copake Highway Department is currently using pre-wetting with liquid calcium chloride.

The use of pre-wetting is most effective in storms having pavement surface temperatures above about 12°F, and when necessary to spread material on packed, icy or dry pavement. Using pre-wet solid ice control chemicals on pavements having sufficient available moisture (loose snow, slush, water) and warmer temperatures (above 23°F) will not significantly improve the effectiveness of the solid ice control chemical.

II.F.5 Factors that Impact the Choice of Ice Control Treatments and the Application Rates of Snow and Ice Control Materials

II.F.5.a Pavement Surface Temperature

Pavement temperature is one of the most important factors that impacts treatment decisions. A number of factors influence this temperature and understanding them will aid in making treatment decisions.

SOLAR RADIATION OR SUNSHINE

Solar radiation can warm surface temperatures significantly above air temperature. The darker the surface, the more pronounced this effect will be. It is not uncommon to have surface temperatures 30 to 40 Fahrenheit degrees above the air temperature early in the afternoon. As the angle of the sun above the horizon increases, solar warming increases. The lowest sun angles occur at the winter solstice and at sunrise and sunset of each day.

CLEAR NIGHT SKY RADIATION

In the same way the sun warms surfaces through radiation, clear night skies, with little or no wind, cool surfaces. This can result in pavement surface temperature being colder than the adjacent air temperature. This condition often allows black ice or frost to form on the pavement surface. This cooling is also related to the subsurface temperatures and the time of the year.

GEO-THERMAL EFFECTS

Subsurface temperature influences pavement surface temperature primarily through thermal conduction. In the fall, the earth is still warm and short-term air temperature drops below freezing, absent radiation effects, will probably not cause the pavement surface to fall below freezing. During the spring end of the season, pavement surface temperatures will remain cold although the air temperature is warmer (absent radiation effects). Bridge decks may freeze quicker than adjacent road surfaces in the fall due to the lack of thermal conduction provided by the earth. However, in the spring, bridge decks can warm more quickly than surrounding surfaces for the same reason.

AIR TEMPERATURE AND WIND

Absent radiation and geo-thermal effects, the pavement surface temperature will always be moving toward the adjacent air temperature. The rate of temperature change is usually slower than changes caused by radiation or geo-thermal effects. However, with increasing wind speed, the rate of pavement temperature change due to air temperature will increase.

TRAFFIC

Traffic can slightly increase pavement surface temperature as a result of tire-road friction and the radiant effects of engine and exhaust systems.

II.F.5.b Dilution of Ice Control Chemical

There are several factors that influence how quickly an ice control chemical reaches “critical dilution” or the freezing point.

WATER OR SNOW AND ICE ON THE PAVEMENT AT THE TIME OF TREATMENT

This is largely due to the effectiveness of the plowing operation or accumulation on the road if there is no plowing prior to the chemical treatment. The more water or snow/ice on the pavement at the time of treatment, the more quickly it will dilute the ice control chemical.

ICE CONTROL CHEMICAL FORM

Liquid ice control chemicals are quite dilute (23% - 32%) to begin with. With dilution, they will reach the freezing point more quickly than solid chemicals that are nearly 100% chemical.

ICE CONTROL CHEMICAL TYPE AND GRADATION

Some solid chemicals go into solution more quickly than others. Their potential for critical dilution is greater. Finer graded solid chemicals also go into solution more quickly. Different chemicals also have different ice melting rate characteristics.

ICE OR WATER CONTENT OF THE EVENT

The ice content of snow and ice events varies dramatically. Light, fluffy dry snow has an ice or water content in the range of 5%. Wetter heavier snow may be as high as 80% ice or water. Rain, freezing rain, and sleet all have nearly 100% water or ice. Higher ice content events will dilute ice control chemicals more rapidly.

EVENT INTENSITY

The more intense the precipitation rate, the quicker it will dilute an ice control chemical.

CYCLE TIME OF CHEMICAL TREATMENTS

The greater the time between treatment cycles, the greater the opportunity for dilution. However, cycle times should be long enough to allow the chemicals to work.

CLEARING ABILITY OF PLOWS

The more snow and ice mechanical equipment removes, the less dilution will occur in the following chemical treatment.

ICE-PAVEMENT BOND AT THE TIME OF TREATMENT

This may be the single most important factor effecting chemical dilution. If there is ice-pavement bond, more ice control chemical will usually be required in order to be effective. The thickness of the bonded ice is also important. Very thin ice will require little or no additional ice control chemical while thick ice and snow pack will require significantly more. The following are indications that there is not ice-pavement bond:

- A spray of water will be produced by moving vehicle tires.
- On loose snow or slush-covered roads, the track created by moving tires will appear bare.
- There will be many bare spots on freshly plowed pavement.
- Scraping the snow or ice on a pavement with a plow (or shovel) will easily expose the pavement surface.
- The plow will make a louder noise if there is no bond

TRAFFIC

Traffic can have positive and negative effects on ice control efforts. Mechanical agitation helps break up snow and ice that have been weakened by the ice control chemicals, aids in allowing chemicals to go into solution quicker and keeps some potentially frozen brine solutions from actually solidifying. Traffic can also remove ice control chemicals from surface and consolidated snow to form pack. Vehicle generated wind and natural wind can displace solid chemicals and cause tire spray to leave the pavement environment.

II.F.5.c Ice-Pavement Bond at the Time of Treatment

If there is ice-pavement bond at the time of treatment, more ice control chemical will be required to penetrate the ice, break the bond and remain above critical dilution until the next treatment. Very thin ice would be an exception to this.

II.F.6 Deciding on an Ice Control Treatment

Every time a snow or ice treatment is being designed, as much of the following information as possible should be on hand or estimated:

- The level of service prescribed by Town of Copake Highway Department policy;
- Present pavement temperature;
- Trend of the pavement temperature;

- Snow and ice conditions on the pavement
- Traffic volume and timing
- Precipitation type and intensity

Once some determination of the items above and other operational considerations has been made, a decision on treatment can be made. It is likely that every treatment will be different as the critical factors are always changing.

Table 4 (Recommended Salt Application Rates) summarizes the most recent available guidance for ice control using salt. Here the factors that relate to pavement surface temperature and ice-pavement bond are displayed in a fairly simple matrix. The ice - pavement bond characteristic determination can be made by operators or supervisors in the field using the guidance in II.F.5.b.

Table 4 – Recommended Salt Application Rates

Pavement Temperature (°)	Ice Pavement Bond	Application Rate, lb/lm
		Solid & Pre Wet Solid products
Over 32	No	125
	Yes	250
30 to 32	No	150
	Yes	325
25 to 30	No	200
	Yes	400
20 to 25	No	225
	Yes	475
15 to 20	No	250
	Yes	500
Below 15	No	275
	Yes	600

II.F.7 Application Techniques for Solid Ice Control Chemicals

After the ice control treatment for prevailing conditions has been decided, the final step is to get the designed treatment in the right location at the right time. There are a number of techniques for spreading solid chemicals that can optimize treatment effectiveness:

TRAVEL LANES

Try to place solid ice control chemicals in a fairly narrow band near the high edge of each lane on two lane highways. On multi-lane highways, a more general distribution may be used in spreading on more than one lane.

BRIDGES AND OTHER ELEVATED STRUCTURES NOT RESTING ON EARTH

In the fall and at other times when there is a rapid, severe, decrease in air temperature, elevated structures are likely to be colder than adjacent pavement on earth. The application rate may be increased by up to 20 percent on these structures so chemical solution freezing will not occur or will occur at about the same time as the surrounding pavement. Toward spring, when air temperatures are warming, structure temperatures are likely to be warmer than the surrounding pavement. Higher application rates are not necessary in this situation.

STRONG CROSS WINDS AND BLOWING AND DRIFTING SNOW

When spreading in strong cross winds, try to keep the spreader upwind of the intended spread location. If the wind is too strong, and the pavement temperature is low, spreading may not be appropriate.

BANKED OR ELEVATED CURVES

Try to keep the spread pattern on the high side of elevated curves. As the chemical works, chemical brine will migrate over the remainder of the pavement.

PARKING AREAS AND WALKWAYS

Spreading ice control chemicals as evenly as possible over the entire paved area is recommended for parking areas and walkways. These areas present an opportunity for pre-event anti-icing with solid chemicals as traffic will not displace them very readily from the surface.

THE WORST CASE SCENERIOS

The worst cases usually occur when the chemical treatment is quickly overwhelmed (diluted) by excessive amounts of water or ice. Blizzard conditions (intense snowfall, wind, very cold temperatures) quickly dilute ice control chemicals and render them virtually useless. If the pavement temperature going into and coming out of a blizzard is expected to be low, then plowing only is probably the best strategy. After the blizzard if it is still very cold, use abrasives as necessary until warmer temperatures will allow chemical de-icing to work. If the pavement temperature throughout and after the blizzard is likely to be fairly warm, a treatment with an ice control chemical before or early in the storm followed by plowing only throughout the storm, will make de-icing at the end of the storm much quicker.

Rapidly accumulating freezing rain is a major maintenance concern. The best strategy here is to apply solid ice control chemicals, at a high rate, in very narrow bands in the high side wheel path of each lane. Usually, this will provide a location in each lane that will have enough friction to allow vehicles to stop and steer.

11.F.8 Materials Spreading Equipment

Materials spreading equipment is most efficient and effective when associated with plow trucks. Independent plowing and spreading operations require almost impossible coordination. By spreading chemicals on freshly plowed surfaces, the chemicals will dilute less and last longer. Most chemicals need time to work. Uncoordinated plowing that removes chemicals from the surface too soon is wasteful.

There are a variety of solid material spreader types used by Town of Copake Highway Department. These include V-Box (slide-in or frame mount), and all season body style dump trucks.

II.F.8.a Spread Pattern Control

Most commercial materials spreaders have the capability of adjusting the spread pattern they deliver. The most common device for spreading solid materials is a vanned spinner plate. The distance material is cast is controlled by the speed of the spinner plate. The faster the spinner plate rotates the farther it will cast material.

The direction of cast from spinner plate is controlled by the direction of rotation of the spinner and the location of the point where the material drops onto the spinner plate. Material dropped on one side of the spinner plate is generally discharged on the opposite side. Deflectors or skirts that divert the cast material downward provide additional control. Once deflectors are controlling the spread, the effect of spinner speed is diminished.

The proper spread pattern adjustments should be determined on the floor of the chemical storage facility. By pushing the discharged material into a windrow that runs parallel to the back of the spreader, a good indication of spread pattern can be obtained. Spread patterns determined by this method should be field verified by observing the distribution under actual operating conditions and making adjustments as necessary. The spread pattern for liquid distribution systems is usually accomplished by adjusting the direction and spacing of the nozzles. Observing the pattern is the best method to determine if it provides the desired distribution.

II.F.8.b Spreading Speed

The potential for solid ice control chemicals to bounce and scatter increases with increasing truck speed. Spreading speed should be as slow as possible, consistent with maintaining a safe speed in traffic.

II.G Post-Storm Activities

II.G.1 Post-Storm Evaluations

Post-storm evaluations should be conducted at the crew level. The following should be discussed and significant findings/results should be committed to record:

- Personnel issues
- Materials and materials management issues
- Equipment issues
- Safety issues
- Weather and information system accuracy
- Observed storm conditions
- Treatment effectiveness and pavement conditions
- Motorist response issues
- Coordination and cooperation issues
- Effectiveness and efficiency of safety restoration activities
- Melt water control
- Snow containment features and potential problems on bridges
- Safety appurtenances – attenuators, median and safety barrier, guard rail, etc.
- Traffic restriction areas
- Narrow raised features
- Signs and delineators
- Sight distance restorations
- Drainage features
- Raised obstructions

II.G.2 Post-Storm Operational Tasks

The following is a partial list of post-storm operational tasks that should be accomplished:

- Asset inventory (number and operational status)
 - Personnel
 - Materials
 - Equipment
 - Information system
- Treat Persistent Snow and Ice Conditions
 - Blow-over areas
 - Freeze-back areas
 - Areas with snow pack or ice
- Road Maintenance Activities
 - Pothole patching
 - Appurtenance repair
 - Brush and tree work
 - Sign and delineator work
- Abrasives clean-up in critical areas

- Equipment repair, cleaning, maintenance and re-calibration
- Maintenance and inventory of ice control materials
- Yard and facility clean up
- Repair of damaged safety appurtenances, signs, etc.
- Parts and fuel inventories

II.H Post Season Activities

II.H.1 Evaluation of All Elements of Snow and Ice Control Operations During the Past Season

The following is a partial list of topics that should be discussed, evaluated and committed to writing by the Town of Copake Highway Department following the winter season:

- Personnel
- Materials – availability, management, problems, etc.
- Equipment
- Maintenance of equipment
- Safety
- Treatment effectiveness
- Weather and other information systems
- Routing and response
- Level of service
- Cooperative agreements and inter-agency cooperation
- Contracts
- Emergency response/management
- Media and public information

II.H.2 Post Season Equipment Maintenance

The following equipment should be repaired, given use or time-based maintenance, and prepared for storage as required:

- Material spreaders
- Pre-wetting systems
- Storage tanks and pumps
- Plow equipment
- Trucks, loaders, graders, etc.

II.H.3 Materials, Equipment and Parts Inventory and Acquisition Activities

With the long lead-time required to acquire commodities, the inventory and purchase activities for next season should begin for:

- Abrasives
- All ice control chemicals
- Plow equipment
- Safety equipment
- Spare parts

II.H.4 Continuous Improvement Activities

Town of Copake Highway Department is committed to continuous improvement of all of its operations. Snow and ice control is no exception. Forums available at all levels of Town of Copake include:

- Direct communication with the office of the Town of Copake Highway Superintendent
- Task specific employee meetings;
- Suggestion program;
- Customer interaction;
- Training.

III. MATERIALS (ROAD SALT) MANAGEMENT PLAN

III.A Background

Road salt (sodium chloride) can have adverse environmental, infrastructure and vehicle effects. Potential environmental effects have been identified in the areas of:

- Surface water
- Ground water
- Soils
- Vegetation
- Wildlife

However, these effects have been only observed in situations where:

- Highway salting was excessive
- Uncovered stockpiles of salt and sand/salt mixtures were allowed to remain exposed to the elements
- Unique wind patterns and earth geology permitted a rapid departure of salt from the highway or stockpile environment

Vehicle and infrastructure effects are well known and are generally accommodated in the design of these elements.

Salt is the most common and least expensive ice control chemical and is likely to be the material of choice well into the future.

With the above in mind, it is the Town of Copake Highway Department's policy to create a reasonable balance among safety, cost, and environmental responsibility with its snow and ice control operations.

III.B Situational Analysis

Town of Copake Highway Department is not aware of any locations within the zone of influence of highway salting where road salt is creating severe negative environmental effects.

III.C Salt Management Plan

Town of Copake Highway Department will utilize "best practices" as the primary tool in salt management.

III.C.1 Highway Use

Town of Copake Highway Department will do the following in support of this salt management plan:

- Use only the amount of salt necessary to provide a satisfactory level of service for individual combinations of weather and road conditions
- Calibrate all materials spreading equipment to allow the proper application rates of salt
- Upgrade equipment over time to include ground speed materials application rate control
- Acquire technology to assist in better defining weather and road conditions
- Conduct operations in an efficient and effective manner
- Use pre-wetting of salt when operationally necessary
- Train Town of Copake Highway Department employees in the use of appropriate snow and ice control procedures and the importance of salt management

- Use the principles of **CONTINUOUS IMPROVEMENT**

III.C.2 Non-Highway Considerations

- Town of Copake Highway Department stores all its salt and sand /salt mixtures under structural cover
- Trucks will be loaded only to a point below where spillage is likely to occur
- All salt spillage in the yard will be cleaned up ASAP

APPENDIX I

GLOSSARY OF SNOW AND ICE CONTROL TERMS

SNOW PLOW TERMS

Air Foil A device placed on the back of a dump body or materials spreader that redirects and accelerates air passing over the truck. This is intended to keep the rear of the truck and materials spreader reasonably clear of snow build-up.

Angle of Attack The horizontal angle (less than 90°) formed in plan view where the plow blade face deviates from a position that is parallel to the front grill of the plow truck

Blade or Cutting Edge The replaceable portion of a plow that is closest to and is in contact with the pavement surface

Ice blade A specialized plow blade that is designed to cut ice; these blades are usually placed on underbody plows that have down pressure capability

Moldboard The portion of a plow between the top and the blade

One-Way Plow or Funnel Plow A front mounted plow that will only cast snow in one direction (usually to the right)

Rake Angle The vertical angle of the plow blade (cutting edge) relative to a perpendicular line from the pavement surface

Reversible Plow A front mounted plow that is adjustable to cast snow: left, right, or straight ahead

Snow Blower, Snow Thrower or Rotary Plow A front mounted device, comprised of augers that move the snow to an impeller that throws the snow through a chute

Underbody or Belly plow A plow that mounts between the front axle and the drive axle(s) of a truck or motor grader

“V” Plow A front mounted plow that simultaneously cast snow to the left and right

Variable Geometry Plow This is a front mounted plow with the ability to change the geometry of the moldboard

Wing Plow. A plow mounted on either side of the side of the truck, or both, that extends the plowing width of a front plow or an underbody plow; can also be used for benching.

SNOW PLOWING TERMS

Benching or Shelving Removing the upper portions of accumulations of snow on the shoulder or near- shoulder, usually with a wing plow.

Close Echelon Plowing. Snow plows that are arrayed across the pavement in a way that prevents traffic from passing the operation. This prevents traffic from passing through windrows of plowed snow and is the safest and most cost effective procedure for high volume multi lane highways.

Snow Plowing The displacement of snow from paved surfaces with plows and wing plows.

Snow Removal Physically relocating areas of accumulated snow. This is usually a slow operation that may be accomplished with loaders and snow blowers

Tandem Plowing Snow plows that operate in sequence, at a distance apart, that allows traffic to safely pass the operation.

Windrow or Berm A linear (parallel to highway center line) accumulation of snow cast by a plow, other equipment or wind.

STRATEGIC AND TACTICAL TERMS

Anti-icing This is a proactive strategy that places and maintains a sufficient quantity of ice control chemicals on the pavement surface before or very soon after precipitation or ice formation begins. This is done to prevent bonding of snow and/or ice to the pavement. It can also be employed after a successful deicing operation. When anti-icing methods are properly employed, they can achieve high levels of service for sustained periods of time.

Deicing This is a reactive strategy for dealing with snow or ice that has already bonded to the pavement surface. Deicing is most effectively accomplished by spreading a coarse graded (rock salt) solid or pre-wet solid ice control chemical on the surface of the bonded snow or ice. The coarse particles will melt through the snow and ice, break the bond, and then produce a chemical solution that flows across the pavement surface between the packed snow/ice and road surface. Any loose snow or ice should be removed by subsequent plowing. **Sufficient time is necessary to allow the salt to work before plowing commences.**

Delayed Treatment Delaying or not applying ice control materials is a tactic that may be used in support of the anti-icing strategy. Road and weather conditions must be closely monitored to ensure success with this tactic. This tactic should be considered when pavement temperature is likely to remain above freezing, or during “dry” snow and blowing snow events where pavement surface temperature is below 15° F and there is no residual ice control chemical on the pavement. Chemicals should not be applied in conjunction with plowing operations at these low temperatures or when plowing blowing and drifting snow at these low temperatures. Usually snow will not bond to the pavement and can be effectively removed by plowing alone. Traffic will whip the rest of the snow away. In this situation chemicals, or the chemicals in abrasives, may make the snow stick to the pavement, causing icy spots that require continuing treatment.

Level of Service (LOS) Desired or observed pavement conditions at various points in time, during and after winter weather events

Temporary Friction Improvement This is an immediate and short-term improvement in surface friction that is achieved by spreading abrasives or abrasives/chemical mixtures on the snow/ice surface. This method may be used in low level of service situations and where low pavement temperatures exist (below 15° F). It is also useful on unpaved roads (with no chemical or the least amount of chemical possible). A major disadvantage of this method is that its effectiveness degrades quickly with traffic. Therefore, it is very important to monitor road conditions to determine if additional treatment is necessary.

ICE CONTROL MATERIALS TERMS

Abrasives Any solid material applied to the pavement to increase friction

Anti-caking Agent A substance added to solid ice control chemicals to prevent caking or adhesion of the individual particles

Brine A solution of one or more salts

Chemical Concentration. The percent (by weight) of a chemical in a liquid or solid product

Chemical Dilution Reducing chemical concentration by adding water or other substances

Chemical Form The physical state of the chemical (solid or liquid)

Endothermic Absorbs heat or becomes colder when going into solution

Eutectic Concentration The solution concentration that will produce the eutectic temperature.

Eutectic Temperature The lowest temperature that an ice control chemical will melt ice or prevent ice from forming

Exothermic Gives off heat or becomes warmer when going into solution

Gradation or Grain Size Distribution This is the proportion of solid material that is retained on specified screen sizes

Hydrometer A device used to measure the specific gravity of liquids

Hygroscopic The property of having the ability to draw water from the air

Ice Control Chemical. Any chemical applied to surfaces that will prevent ice from bonding or melt ice that has already formed

Liquid Chemical The liquid form of a chemical or combinations of chemicals; usually a solution

Mixed Abrasives A mixture of abrasives and ice control chemicals

Phase Diagram A graph that shows the relationship between: solution concentration, solution freezing point and solution (pavement) temperature

Solution A generally clear combination of water and other dissolvable substances

OPERATIONAL PROCEDURE TERMS

Automatic Anti-Icing /Deicing Systems Liquid chemical distribution systems that are placed at strategic highway and bridge locations that automatically apply liquid ice control chemical to the road when specified conditions are present

Dry Run Driving the snowplow route, beat or run in non- snow and ice conditions to become aware of features that may impact snow plowing and spreading materials

Circle of Safety A visual technique used by equipment operators to gain awareness of evolving situations all around the equipment

Passive Snow Control The control of blowing and drifting snow by using snow fence, plantings or highway design features

Pre-Wetting Adding a liquid ice control chemical, or water to solid ice control chemicals before placement on the road

Pre-Treating Placing an ice control chemical on the road before the beginning of a winter weather event

Snow, Beat, Route or Run Maps These are maps that show individual or groups of snow plow routes under various level of service and available equipment conditions; hazards and special treatment areas are usually identified

Treatment Cycle Time The time it takes for a truck to return to retreat a point on the beat/run, after treatment, including any reloading time; if reloading is required for every treatment run, it could be the time between leaving the loading point for successive treatment runs

Wet Run Driving the snowplow route, beat or run during winter weather conditions to identify features that may impact snow plowing and/or materials spreading

MATERIALS SPREADER TERMS

Application Rate The amount of material being discharged per lane mile by the spreader or distributor (pounds per lane mile or gallons per lane mile) [discharge rate divided by the number of lanes being treated]

Calibration The procedure for determining that the desired rates of discharge are capable of being delivered by the materials spreader, and what settings of the control features will produce the desired rates

Discharge Rate The amount of material being discharged, per mile, by the spreader or distributor (pounds per mile or gallons per mile)

Spread Pattern The transverse distribution of the ice control product across the highway (middle third, full width, high side wheel path, strips, etc.)

Ground Speed Control the material being distributed by the spreader is automatically controlled to deliver the proper application rate, regardless of ground or truck speed

PAVEMENT CONDITION TERMS

Black Ice A popular term for a very thin coating of clear, bubble free, homogenous ice that forms on a pavement; there are a number of mechanisms that will produce thin ice

Blow-Over A relatively minor accumulation of snow on the road that is primarily deposited by the wind. Road or lane closure would be unlikely if not removed.

Damp There is a light coating of moisture on the pavement, with no visible water drops

Dry No wetting is apparent on the pavement surface

Frost A “white” non-homogenous coating of ice that usually forms on surfaces when the air temperature is above freezing

Hard Pack or Snow Pack This is formed when saturated snow is compacted by traffic, usually accompanied by a drop in temperatures and the resulting ice is bonded to the pavement.

Ice/Pavement Bond Compacted snow or ice that adheres to the pavement so strongly that only ice control chemicals or increasing pavement temperature will break the bond

Loose Snow Unconsolidated snow that can be blown by the traffic or wind into windrows, or off the road

Slush An accumulation of snow that lies on an impervious base and is saturated with water in excess of the freely drained capacity. It will not support any weight when stepped or driven on but will “squish” until the base support is reached.

Snow Drift A significant accumulation of snow on a road that is primarily deposited by the wind. If not removed timely, road or lane closure could result.

Thick Ice A much thicker coating of ice on the pavement than thin ice, formation may result from: freezing rain, freezing of ponded water, or freezing of melt water that is not able to drain properly. It may be clear or milky in appearance, and is generally smooth although it can have a rough surface

Thin Ice A thin, clear coating of ice where the pavement surface can be seen; often called black ice

Wet The road is surface saturated with water from rain or melt water. Runoff and puddles may nor may not be present

WINTER WEATHER TERMS

Blizzard A long duration, wide area, snow event that is characterized by a heavy rate of snowfall, high winds, and low temperatures.

Blowing Snow Airborne snow that is primarily being transported by the wind; precipitation may or may not be occurring

Drizzle Light rain that is characterized by very small individual water droplets

Freezing Rain. Super cooled droplets of liquid precipitation falling on a surface whose temperature is below or slightly above freezing, resulting in a hard, slick, generally thick coating of ice commonly called a glaze or clear ice or non-super cooled raindrops falling on a surface whose temperature is well below freezing will also result in a glaze.

Frost. Also called hoarfrost. Ice crystals in the form of scales, needles, feathers, or fans deposited on the surfaces cooled by radiation or other process. The deposits may be composed of drops of dew frozen after deposition and of ice formed directly from water vapor at a temperature below 32° F (sublimation). Frost most often occurs when air temperature is above 32 degrees F and pavement temperature is 32° F or below and is at or below Dew Point.

Heavy Rain Rain, seemingly falls in sheets; individual drops are not identifiable; heavy spray can be observed several inches above the pavement surface

Heavy Snow Snow that is falling at a rate of more than 1 inch per hour and visibility is less than ¼ mile

Light Rain Small liquid droplets falling at a rate such that individual drops falling on a wet surface are easily detectable

Light Snow. Snow falling at the rate of less than ½ inch per hour: visibility is greater than ½ mile

Moderate Rain Liquid drops that are falling are not clearly identifiable on the pavement surface and spray from the falling drops is observable just above surface

Moderate Snow. Snow falling a rate of ½ inch to 1 inch per hour per hour; visibility is greater than ¼ mile and less than ½ mile

Radiometer or Infra Red Thermometer A non-contact device that measures the surface temperature of pavements and other objects

R.W.I.S. (Road and Weather information System) A system that is comprised of atmospheric and weather sensors, pavement temperature, and chemical sensors, a computer and software system for arraying data and data analysis, and a communications system to move the data from point of measurement to the end user

Sleet or Ice Pellets A frozen mixture of rain and snow (pellets) that had been partially melted by falling through a layer of the atmosphere having a temperature above freezing, and subsequently refrozen by a colder layer or air near the surface of the earth

White-out A short duration situation, within a snow storm, where visibility drops to only a few feet

APPENDIX II SOURCES OF INFORMATION USED TO CREATE THIS DOCUMENT

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