NEW YORK STATE
DEPARTMENT OF TRANSPORTATION

OPERATIONS DIVISION
OFFICE OF TRANSPORTATION MAINTENANCE

HIGHWAY MAINTENANCE GUIDELINES
CHAPTER 5

SNOW AND ICE CONTROL

April, 2006 (Revised January 2012)

NEW YORK STATE DEPARTMENT OF TRANSPORTATION

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5.0000 SNOW AND ICE CONROL ON STATE HIGHWAYS

5.0100 General Principles

Our State's society and economy depend upon the all-weather use of our streets and highways. When the State system is closed or the capacity reduced, the traveling public, industry and commerce are all affected. Also, accidents due to snow and ice on our pavements can be very costly in terms of property damaged, personal injuries and human life.

5.0200 Definition of Terms

The terms "shall, must, should, recommended and may" used in Section 5 have the following meaning:

Shall and Must	-	A required course of action
Should and Recommended	-	A suggested course of action
May	-	An optional course of action

5.0300 Goal

The Department's goal is to provide highways that are passable and reasonably safe for vehicular traffic as much of the time as possible within the limitations imposed by weather conditions and the availability of equipment, material and personnel. It is recognized that due to resource limitations and weather conditions, pavement surfaces will be snow covered and/or slippery some of the time. The traveling public must exercise caution and drive appropriately in those situations.

5.1000 PREPARATION FOR SNOW AND ICE CONTROL

5.1100 Objective

The objective of planning for snow and ice control operations is to have sufficient resources and knowledge to effectively combat snow and ice conditions that routinely affect the State highway system, within budgetary and available resource constraints.

5.1200 Goal

The goal of the preparation effort is to provide for a reasonable and timely response to snow and ice events which affect the State highway system.

5.1300 Methodology

5.1301 Rationale for a Traffic Based Level of Response

Traffic volume has been selected as the basis for level of response primarily because it reflects (1) the degree of difficulty in snow and ice control, (2) the speed of vehicles using the facilities, (3) the relative skill and familiarity of the highway users generally traveling on the highways, and, (4) the number of people that are inconvenienced if our efforts are delayed.

5.1302 Highway Classification for the Purpose of Snow and Ice Control

Class A1 – Expressways with low average running speeds. Examples: Long Island Expressway, Interurban, and Intercity State Routes with traffic volumes approaching or exceeding capacity. These highways are at, near, or over the practical capacity of the highway at certain times during the day. Any interruptions delay some vehicles, thereby raising the volume in a given section to or above the possible capacity. The speed then drops to near zero and complete congestion results. In cases like this, the speed of the Snow and Ice Control vehicle is not governed by the operator or by the efficiency of the operation, but by forces completely beyond control. However, traffic must be kept moving before that complete congestion point is reached. This signifies that, so far as practical, priority attention should be given to these highways.

Class A2 – Expressways with high average running speeds. Typically, these are Interstate type highways with a one-way design hourly volume of 500 or more vehicles per hour. The slowing of a few vehicles does not mean complete congestion of the highway. These highways give Snow and Ice Control vehicles some freedom to maneuver, and plow speed can be controlled by the operator.

Class B – Major State highways with a one-way design hourly volume from 200 to 500 vehicles per hour. As with A2 highways, the immediate need for snow and ice control is not as critical as A1, since vehicles can normally travel without congestion at reduced speeds.

Class C – Minor State highways with a one-way design hourly volume less than 200 vehicles per hour. On these highways traffic volumes are low, motorists are more apt to be familiar with the highway, and congestion point is rarely reached. Plowing speeds can, generally, be controlled by the plow operator.

5.1303 Locations That Require Special Consideration

Locations such as steep grades, intersections, sharp curves, bridges, and railroad crossings should receive special consideration in planning snow and ice control operations, regardless of the highway classification. Section 5.3307 has more information on these types of locations. Areas subject to Great Lakes squalls, or sections susceptible to sudden icing, or subjected to abnormal drifting are also special conditions that warrant individual consideration. There are special snow and ice areas that may require snow removal. These include: ditches and culverts (to provide for proper drainage), bridges, intersections, signs, safety appurtenances, facility driveways and loading areas, and certain commercial areas that could otherwise possibly impair traffic flow and sight distance.

5.1304 Design Rate of Snowfall

A snowfall rate of 1.1 inches per hour has been determined as being exceeded on a few times each year in all areas of the State. It is considered the maximum rate of fall for which staffing is economically possible.

5.1305 Average Truck Speeds (for planning purposes)

Through research, it has been determined that the average plow truck speed (including deadheading and reloading) is 16.5 MPH for highway classes A2, B, C, and D and 14.5 MPH for class A1 highways. These figures help in determining plow beats.

5.1306 Assignment of Snow & Ice Trucks for Various Classes of Highway

The distribution of snow and ice trucks to the Regions shall be:

Highway Class	Lanes Miles/ Truck
A1	20
A2	30
B	30
C	30

5.1307 Plowing Capability of Snow and Ice Trucks

The GVWR (Gross Vehicle Weight Rating) helps determine the plowing capacity of the truck. Trucks with a minimum GVWR of 36,000 pounds will handle the rate and frequency of storms anticipated, spread sufficient material per trip, and minimize the possibility of complete impassability of State highways during less frequent but more severe storms.

5.1308 Spreading Capacity of Snow and Ice Trucks

The spreading capacity of the large dump trucks used for snow and ice control on State highways should be at least 6 C.Y. This will minimize the labor and equipment cost per yard of material spread and provide sufficient material coverage for normal beats. Time lost during reloading is not productive and necessitates increased use of equipment and personnel resources.

5.1309 Other Types of Snow and Ice Equipment That Must Be Considered During Planning

A. Loading Equipment

Sufficient loading capability must be provided to load trucks without unreasonable delays. Additionally, plowed snow must be removed from certain areas on and around the highways. Front end loaders having sufficient capacity of about 2 C.Y. are generally suitable for this purpose. However, in some of our small work locations (1 – 3 trucks) a medium size loader with a 1 C.Y. bucket has proven to be adequate for the loading requirements. Conversely, at some of our larger work locations (greater than 8 trucks) loaders with a 3 C.Y. capacity may be necessary.

B. Graders

Occasionally, despite reasonable effort, snow pack will form on the highway. Graders are suitable for mechanically removing this pack. However, in most cases they are too slow for efficient removal of ordinary snow from the highway. If equipped with a wing plow, they are suitable for benching and some post storm cleanup.

C. Snowblowers

There are some drifting areas where accumulating snow exceeds our capacity to remove it with plow trucks. For this situation, snowblowers having sufficient size and capacity are the only efficient way to open and/or keep the highway open. They are also useful in loading and hauling operations.

D. Light Weight Equipment

There may be some bridges on the highway system that can not accommodate the weight of heavy plow trucks. Additionally, the inside raised shoulder in a roundabout needs a smaller vehicle for snow removal. A variety of lighter plow-equipped trucks, including 4x4 pickups, should be available to maintain these bridges and roundabouts.

E. Large Capacity Loaders

Where traffic volume is extremely high, and there is an occasional heavy snowfall, highways can be closed due to large numbers of stranded vehicles. In such situations availability of front end loaders having bucket capacities of 5 C.Y. or more is desirable. These loaders are capable of removing stranded vehicles from the highway as well as efficient snow removal.

5.1310 Equipment Readiness

Major repairs and overhauls of Snow and Ice equipment should be performed well in advance of the anticipated time of need. Adequate resources are needed to be available to perform this work. Our goal is to have the Snow and Ice fleet ready by November 1. For traditional early snow locations this date should be moved up to October 1. Stored equipment (plows, spreaders, snowblowers, etc.) should be given proper lubrication, protection and painting prior to storage. The flight chains on spreaders should be checked for lubrication during storage to prevent seizure. Whenever possible, spreaders should be stored under cover. Snowblowers should be started periodically during the off season to ensure proper operation later. Proper preventive maintenance and daily maintenance of multi-seasonal equipment is a good way to ensure readiness and proper performance.

5.1311 Personnel Readiness

The training of Snow and Ice personnel to safely and efficiently perform their duties should be a continuing effort. Basic Snow and Ice Training for all new employees is essential. Training for both new and experienced employees should be performed in accordance with Transportation Maintenance Instruction 00-02 and Equipment Operator Snow and Ice Manual dated October 2005. Snow Schools, Seminars, and preparation for snowplow competitions are available training forums.

5.1312 Facilities and Stockpiles

Facilities and stockpiles should be located so as to keep deadheading minimized. Salt shall always be stored under cover. The preferred method is in a building. Whenever salt is piled outside, care must be given in its location to mitigate any negative environmental impacts. Salt piles outside shall always be covered. Information on good housekeeping can be found in the Snow Fighters Handbook, published by the Salt Institute, and the Environmental Handbook for Transportation Operations, by the NYSDOT Environmental Analysis Bureau.

5.1313 Weather Information

Accurate weather information is essential to effective Snow and Ice management. Possible sources of this information should be known to all well in advance of the Snow and Ice season. Possible sources are:

A. The NOAA WEATHER RADIO NETWORK

NOAA Weather Radio is a service of the National Oceanic & Atmospheric Administration (NOAA) of the U. S. Department of Commerce. It provides continuous broadcasts of the latest weather information directly from the National Weather Service offices. Most of the stations operate 24 hours daily. Residency radio scanners equipped to pick up the appropriate frequency can monitor NOAA Weather Radio broadcasts from the following stations:

NOAA STATION	FREQUENCY (M Hz)
Albany	162.550
Binghamton	162.475
Buffalo	162.550
Elmira	162.559
Kingston	162.475

Rochester	162.400
Syracuse	162.550
New York City	162.550
Burlington (Vermont)	162.400

B. Private Weather Forecasting Services

There are a number of private weather forecasting companies that offer a variety of services. NYSDOT has an agreement with a forecasting firm that provides for Regional notification of anticipated Snow and Ice events and other severe weather conditions thru a variety of ways.

C. In-House Weather Information

All Residency Headquarters and Sub-Headquarters have near real-time weather information from sites that cover their area, via the internet. Each Region has a few sites that get satellite feed weather information as a backup. These systems provide excellent data on storm location and timing.

D. Road Weather Information Systems (RWIS)

Recent years have seen an increase in the use of RWIS systems at both the national and state level. These systems provide site specific weather and pavement condition data for both real time and forecast purposes. This tool can provide the manager with valuable information on when personnel will be needed, chemicals to be applied and after storm conditions.

E. Knowledge, Experience, and Communication with Locations in the Storm Path

Over time, people develop a sense of local weather patterns. Certain bridges and sections of highways tend to be possible problem spots. This information should be communicated to all employees that are likely to have snow and ice responsibilities for those areas. When general storms are approaching, communication with Residencies closer to the storm will yield valuable information on the timing and character of the storm as well as information on the cessation of the storm.

F. Other Sources of Weather Data

Local radio and television stations provide some weather information. The amount and priority are a matter of local station policy. Cable television provides access to a weather channel that provides forecasts 24 hours every day. With all of our work facilities having computers available to supervisors and being tied into the Internet, a variety of weather information is available. The Office of Operations Management, has set up direct links to several weather providers from its home page.

5.1400 Operational Plan

Each Residency shall have an Operational Plan for Snow and Ice Control. At a minimum this plan should include beat descriptions, which include lengths and typical cycle times, chemical and abrasive application rates and amounts for the beats, equipment calibrations, staffing and equipment distribution, storm manager procedures, radio watch procedures, and any special procedures for after storm cleanup. The Operational Plan should be developed by the Resident Engineer, Assistant Resident Engineer and front line supervisors. Its purpose is to have in one document all of the necessary information related to Snow and Ice Control for a particular Residency. The information in this document should be shared with all of the personnel in the Residency, so that everyone knows what is expected. An outline of an Operational Plan can be found in Appendix A.

5.2000 STORM WATCH

5.2100 Objective

The objective for storm watch is to have a set of communication procedures in place which will enable timely mobilization of sufficient personnel to effectively deal with snow, ice or other possible emergencies and provide the public and other agencies a forum for reporting potentially hazardous highway related conditions.

5.2200 Goal

The goal for storm watch is to effectively use the selected set of communication procedures to provide timely response to snow, ice and other winter emergencies.

5.2300 Methodology

The methodology will vary among Residences and shall be based on such factors as traffic volume, historical rate and frequency of storms, population centers,

working hours of large employers within the Residency, the necessity of maintaining access to vital services such as hospitals, emergency services, and the necessity of maintaining a consistent level of service on major routes of travel. Continuous telephone watch shall be maintained during the snow and ice season in each Residency. Portions of this may be in the form of commercial services or arrangements with other municipal service agencies, or through another Residency, or through DOT Traffic Management Centers.

5.2301 Storm Manager

The key to an effective snow and ice program is to have the necessary resources in place ready to go when the storm begins. In order to have the resources in place, a Residency Storm Manager must be designated. That person's responsibility is to monitor all of the available forecast information and determine the approximate start time for the storm. With an approximate storm start time, type of storm, and anticipated temperatures (pavement and air) a decision can be made when to have the necessary people and equipment ready to begin snow and ice operations. It is recommended that the storm manager be the Resident Engineer, Assistant Resident Engineer or Highway Maintenance Supervisor 2.

5.2302 Supervision and Preparedness

During periods when snow or ice events are anticipated, it is recommended that supervisors, in light vehicles having communications capability, patrol areas likely to be affected by the event for the purpose of directing the appropriate response. The availability of RWIS and other information resources may diminish or negate the need for patrols.

In situations where a snow or ice event has a high probability of occurring, it is recommended that trucks, carrying the appropriate material, be pre-positioned to begin spreading on their beats as soon as the event starts.

5.3000 Snow Control

5.3100 Objective

The objective of snow control is to provide the traveling public with a passable highway as much of the time as possible, given the constraints of operational resources and the character of the snow event.

5.3200 Goals

Snow control goals will vary with traffic volume and other considerations. Furthermore, the level of service provided will vary with the snow control goals determined to be appropriate given existing conditions. Regular Level of Service should be provided on all classes of highway between 4:00 AM and 10:00 PM Monday thru Friday, and at all times on highways having Average Daily Traffic (ADT) of 50,000 vehicles per day or more. Modified Level of Service should be provided on all classes of highway between 10:00 PM and 4:00 AM Monday thru Friday, and all day Saturday and Sunday, except for highways with and ADT of 50,000 vehicles per day.

The Regional Director may determine it to be appropriate, at his or her discretion, to provide certain highway sections with a higher than modified level of service. Such a determination may occur where it might be necessary to maintain a higher level of service because of unique travel or weather demands. These may include, but not limited to, highway sections serving industrial or recreational areas, other highway sections important for economic activities, or highway sections which may historically receive heavy snowfalls such that the Recommended Maximum Allowable Accumulation Goal, may be routinely exceeded. These variations should be approved by the Regional Director as requested by the Resident Engineer and recommended by the Regional Transportation Maintenance Engineer and documented at the beginning of each snow and ice season, and updated as appropriate during the season.

5.3201 Snow Control Goals – Regular Level of Service

Highway Class	Recommended Maximum Allowable Accumulation During a Storm (Inches)	Elapsed Time After Event End That Full Width of Pavement Should be Cleared (Hours)
A1	2.0	1.5
A2, B, C	2.5	2.0

5.3202 Snow Control Goals – Modified Level of Service

Highway Class	Recommended Maximum Allowable Accumulation During a Storm (Inches)	Elapsed Time After Event End That Full Width of Pavement Should be Cleared (Hours)
A1	2.5	2.0
A2, B, C	3.5	3.0

Plowing should begin as soon as there is enough snow on the pavement to plow. Do not wait for the Recommended Maximum Allowable amounts to be reached before the plowing operation commences.

5.3300 Snow Control Methodology

5.3301 Preparation for Snow Control Operations

A few plows and spreaders should be mounted well in advance of the anticipated date for the first snow storm. As more consistent winter weather approaches, additional units should be readied. All plows and spreaders should be mounted by November 1 as mentioned in Section 1.1310. During the winter season, equipment shall be serviced at the end of each storm. The use of a Truck Check List, such as found in Appendix B, assists an operator in ensuring that all of the critical items are looked at on his or her truck. The trucks and spreaders should be cleaned at the end of each storm.

Ballast, usually in the form of salt or abrasives, provides extra weight needed by the truck to obtain maximum traction for removing snow. The ballast must be removed when the truck is not needed for snow removal.

Blades (cutting edges) and shoes must be inspected by each operator on each shift and changed as necessary in order to prevent moldboard damage and wear.

Properly fit tire chains should be available for each snow and ice vehicle. Conditions such as ice storms may require the use of chains.

5.3302 Snowplowing Procedures – Mainline

A. General

There are a variety of acceptable procedures that will facilitate the removal of snow from the highway and allow for reasonably safe traffic flow. They vary with local traffic conditions, the characteristics of the highway surface and available snow storage area. The paramount objective in all of these procedures is to avoid leaving a windrow or berm of plowed snow between adjacent mainline (travel) lanes where reasonably possible. However, there may be circumstances where insufficient equipment or other conditions may exist that preclude plowing without leaving windrows in certain areas. In such circumstances, windrows may be left, but should only remain in such an area for as brief a period of time as reasonably possible. Depending on road and traffic conditions, plowing speeds should be in the range of 15 MPH to 35 MPH.

B. Two Lane – Two Way Traffic

Plowing shall always be done in the direction of traffic. A one-way plow with right wing is typically used when plowing the snow to the right. The traffic lane and as much of the shoulder as is possible should be plowed clear of the snow in this operation. When a plow truck is plowing to the right, without the right wing, as much of the pavement as possible should be cleared. Some reasonably small amount of plowing over the center line is necessary to clear the pavement. However, plow trucks shall yield the right-of-way to oncoming traffic.

C. Two Lane Section – One Way Traffic

1. Plowing shall always be done with trucks moving in the direction of traffic. Snow should not be plowed to the side of the truck on which traffic has an opportunity to pass unless it is done as part of a close echelon plowing operation that minimizes passing opportunities and will have plowed snow quickly removed from the pavement surface.

2. Typically, the entire passing lane will be plowed in one pass, by plowing the snow to the left if the median is of adequate width to store the snow. This

should preferably be accomplished with a large dump truck equipped with a reversible plow throwing left and a left-hand wing. This truck will typically operate along the right-hand edge of the passing lane so that the plow cuts as close to the lane marking as possible.

3. The entire driving lane should be plowed in the second pass by plowing snow to the right. The truck for this pass should be operated approximately one thousand feet (distance between two reference markers) behind the truck of the first pass. The plowing of the driving lane should preferably be accomplished by a large dump truck equipped with a plow and right-hand wing. This truck will typically be operated along the left edge of the driving lane so as to permit removing the remaining snow, on the entire driving lane and any small area of unplowed snow that may remain on the passing lane, in one pass. This type of plowing is known as tandem plowing. However, it is recommended that both trucks plow in close echelon. This minimizes the chance of vehicles passing and losing control in the unplowed lane. If the trucks leave the mainline plowing operation to plow ramps and intersections it is important that they return to the place they left off as quickly as possible in order to minimize the amount of time sections between “off” and “on” ramps remain in an unplowed condition.

4. If the median is too narrow to store snow, all plowing should be in close echelon and to the right as described in 1. above.

5. There may be circumstances where insufficient equipment or other conditions may exist that preclude plowing without leaving windrows in certain areas. In such circumstances, windrows may be left, but should remain in such an area for as brief a period of time as possible.

D .Three Lane Section – One Way Traffic

1. Plowing shall always be done with trucks moving in the direction of traffic. The inside or left lane should be plowed toward the median or left shoulder if sufficient storage area is available.

2. The center and right-hand lane should be plowed with two trucks utilizing right-throwing plows and wings while traveling in echelon as close together as safely possible. The first truck should generally operate as close to the left-hand edge of the center lane as possible.

3. Should the trucks leave the mainline plowing operation to plow ramps and intersections, it is important that they return to the place they left off as quickly as possible in order to minimize the amount of time sections between "off" and "on" ramps remain in an unplowed condition.

4. Alternative sequencing of the plow trucks is acceptable as long as no windrows or berms of plowed snow are created between adjacent travel lanes. It is recommended that all three trucks plow in close echelon. This minimizes the chance of vehicles passing the center and right lane trucks and then losing control in the unplowed left lane. If it is decided to allow room for vehicles to pass the center and right lane trucks then the distance between the close echelon pair of trucks and the single truck should be a minimum of approximately one thousand feet (distance between two reference markers).

5. If the median is too narrow to store plowed snow, all plowing should be in close echelon to the right.

6. There may be circumstances where insufficient equipment or other conditions may exist that preclude plowing without leaving windrows in certain areas. In such circumstances, windrows may be left, but should remain in such an area for as brief a period of time as possible.

5.3303 Plowing of Ramps and Intersections

In general, ramps and intersections should be plowed at about the same time as mainline sections. However, the character of the storm and traffic conditions may dictate that they be plowed earlier or later than the adjacent mainline sections.

5.3304 Plowing of Shoulders

After pavement and ramps are cleared, the full width of the shoulders should be plowed. It is particularly important that snow be cleared beyond the shoulder high point on banked curves in order to minimize possible re-freeze or snow melt on the pavement. Nose plows should not be used for plowing shoulders. Refer to the Equipment Operator's Snow & Ice Manual.

5.3305 Crossovers, Turnarounds and Gore Areas

Crossovers, turnarounds, and gore areas should be plowed after the storm is over and other elements of the highway have been cleared. These should be done when visibility is good and traffic volume is low.

The use of crossovers during mainline plowing operations is discouraged. Interchanges should be used to the extent possible for the operational movement of plow trucks. When it is necessary to use a crossover it should be of sufficient width to allow the plow truck to be completely off both roadways. Crossovers used as a turn around should be identified in the Operational Plan.

5.3306 Plowing Back and Benching

After the storm is over, plowed snow should be plowed back as far as possible to provide snow storage space in anticipation of the next storm. Care should be taken by the Operator to avoid dragging the wing beyond the paved shoulder. Additional snow storage can be provided by plowing high level snow banks with the wing elevated. This is called benching. The wing should be at least three feet off the pavement to avoid hitting guide rail. If the plow with wing elevated is unable to displace the snow, a snow blower should be used to clear the area.

5.3307 Removal of Snow from Special Areas

A. General

After the storm is over, the shoulders, crossovers and gore areas have been plowed and benching and pushing back operations are underway or complete, the removal of snow from special areas should commence. A list of any special areas, along with any special requirements should be included in your Residency Operational Plan. These operations require loading equipment and hauling vehicles. Front end loaders, snow blowers and heavy dump trucks are usually used for this purpose. If necessary, rental equipment may be considered. This may be available under a Municipal contract or through private rental.

B. Bridges

Accumulated snow should be removed from locations that could melt during the day, drain across the deck, and freeze at night. Bridge drainage features should be cleared to facilitate the designed discharge of water. Bridges having features which prevent plowed snow from leaving the bridge should have accumulated snow removed to make room for the next storm. Particular attention should be given to buildup along concrete barriers on high volume, high speed facilities. Overtime or resources from other residencies or regions may be necessary for this operation to minimize the duration or to facilitate the cleanup effort during off peak hours.

Accumulated snow on bridge sidewalks should be removed. In most cases the local municipality has the responsibility to remove the snow. For those locations with State responsibility, the Residency should develop a plan for the removal of the snow. Working with the local municipalities on this issue is recommended.

C. Impact Attenuators

When possible, accumulated snow should be removed from areas that could affect the performance of impact attenuators. This work may require overtime to minimize the duration or facilitate the cleanup effort during off peak hours.

D. Banked Curves

When possible, accumulated snow on the high side of banked curves should be removed to the shoulder break to minimize the risk of melt water freezing on the pavement.

E. Sag Vertical Curves

When possible, drainage channels should be created in the snow banks on both sides of the highway at the low point in sag vertical curves to minimize the risk of melt water accumulating on the pavement.

F. Ditches and Culverts

When possible ditches and culverts having a history of snow melt water runoff problems should be cleared of accumulated snow prior to anticipated thawing weather.

G. Closed Drainage Systems

The inlets to closed (underground) drainage systems should be cleared prior to anticipated thawing weather.

H. Narrow Median

Accumulated snow should be removed from narrow median areas if it poses possible melt water problems that may otherwise interfere with the traffic control function of the median.

I. Guiderail, Median Barrier and Concrete Barriers (Non- Bridge)

Snow should be removed as close to guiderail, median barrier and concrete barrier as reasonably possible with plow equipment. The complete removal of snow from the traffic side of guiderail and median barrier is not possible with available resources.

J. Roundabouts

In general, roundabouts should be plowed and/or treated as part of the regular plow beats which pass through them. As conditions warrant, one or more of the plow trucks assigned to routes passing through the roundabout should plow the entire circular traffic flow area. Larger facilities may require plow trucks to operate in

tandem to optimize snow removal. The truck apron on the central island should be maintained to insure functionality. Consideration should be given to maintaining sight distances, snow storage capacity and drainage patterns. Heavy snowfalls may require snow removal operations after the storm using loaders, rotary snow blowers or other necessary equipment. Operators should familiarize themselves with the roundabout's curbing and drainage features and should install snow stakes, as needed, prior to the onset of winter weather.

5.3308 Snow Removal from Municipal/Commercial Areas

Within municipal and commercial areas, "reasonable passage and movement" may require loading and hauling snow. This work is to be done only to the extent necessary. Need will be determined by the Resident Engineer. State Forces shall be used to the extent necessary and available. Any combination of State, County, Town and Village forces that is most practicable and applicable under current policy and contract agreements should be used. The clearing of Municipal sidewalks, parking areas, pedestrian refuge islands and center and splinter islands built as part of a roundabout is not intended to be performed or paid for by the State. The Resident Engineer should meet with appropriate municipal officials to coordinate snow removal efforts in these areas to minimize the impact to pedestrians.

Prior to disposing of snow removed from municipal/commercial areas, a check of local rules and ordinances relative to snow disposal should be made for any local requirements. Additionally, a check should be made for applicable watershed rules and regulations made or approved by the New York State Department of Health (P.H.L. 1100), or other regulatory agencies, for required compliance purposes. A list of approved sites should be included in the Residency Operational Plan.

5.3309 Snow Control During Blizzard and White-Out Conditions

Some snow and wind events produce snowfall intensity that severely limits the visibility and performance factors of the plow operator(s). Temporarily curtailing operations under these conditions may be prudent to preserve the safety of plow operator(s), other vehicles using or stranded on the highway and pedestrians that may be in the vicinity of the highway. Most of these events are associated with localized squalls of lake effect snow and are usually of relatively short duration. During these conditions, operators should drive their trucks to a safe location, well off the highway, turn exterior lights off and contact a supervisor for further direction.

Some intense low visibility snowfall/wind events (blizzards) are more sustained and can last from several hours to several days. During these events the overall level of service may be limited to that necessary for supporting local emergency situation response. During this pullback phase, operators waiting for further directions should make appropriate preparations and equipment should be made ready for intense operations when the visibility and/or other difficult conditions improve. Generally, this pullback option should only be used in conjunction with declared states of emergency when non-essential highway travel is prohibited.

5.3310 Vehicle Maintenance

After each event and when any special areas for snow removal have been addressed, maintenance of the equipment should commence. Trucks, material spreaders, loaders and other snow and ice equipment should be cleaned and greased.

5.4000 Ice Control

5.4100 General

It is recognized that it is not possible to provide a "bare" or "wet" pavement surface all of the time. The characteristics of weather events and finite available resources preclude this possibility. The interactive effects of pavement temperature, air temperature, event intensity, and timing of initial treatment, operational cycle time, traffic volume, wind velocity, and solar energy have profound influence on the effectiveness of our ice control measures.

During those times when the pavement surface is not "bare" or "wet" it is incumbent on the driving public to perceive those conditions and operate their vehicles accordingly.

5.4200 Objective

The objective of ice control is to provide a reasonably safe pavement surface given the available resources and limitations imposed by weather conditions.

5.4300 Goal

The goal of ice control is to provide the safest possible pavement surface that climatic conditions and available resources will allow.

5.4400 Methodology

5.4401 Ice Control Methods

There are four basic strategies recognized for ice control used by this Department and many other agencies in the field of snow and ice operations. They are anti-icing, deicing, delayed treatment, and temporary friction improvement.

A. Anti-icing

Anti-icing is a 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. When anti-icing methods are properly employed, they can achieve high levels of service for sustained periods of time. To achieve this success, air and pavement temperatures, precipitation type, humidity, origin and intensity of the storm and predictions from online and/or contracted weather services must be tracked and monitored.

B. Deicing

Deicing is a 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 particulars 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 snow or ice that has not gone into solution should be removed by subsequent plowing. Sufficient time is necessary to allow the salt to work before plowing commences.

C. 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^{o} 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.

D. Temporary Friction Improvement

Friction improvement 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 where low traffic volumes and/or low pavement temperatures exist (below 15^{o} F). A major disadvantage of this method is that its effectiveness degrades quickly with varying levels of traffic therefore it is very important to monitor road conditions to determine if a change in treatment is necessary.

5.4402 Preparation for Ice Control Operations

As with Snow Control preparation, it is critical to have all ice control equipment ready for mounting, on the trucks, well in advance of the first storm. In addition to the spreader units, attention should be given to the liquid chemical equipment. Pumps and connections on the bulk storage tanks need to be inspected and serviced. Saddle tanks on the spreaders, along with hoses, connections and spray bar also need to be inspected and serviced. It is recommended that the saddle tanks be emptied back into the bulk storage tank at the end of every season. Several locations now have distribution tanks with spray bars that slide into small dump trucks. These units need to be inspected and serviced. More information on summer storage, handling and emergency procedures for dealing with liquid chemicals can be found in Appendix B.

5.4403 General Principles of Effective Ice Control

A. Prevent pack – Don't Melt It

Timely application of chemicals very early in a storm, with appropriate follow-up applications, will generally prevent pack from forming. This strategy is more cost effective and safer than trying to remove pack once it has formed.

B. If Chemicals Will Work, Use Them

If the conditions are favorable, ice control chemicals should be applied at the beginning of the storm. With the advent of liquid ice control chemicals, they could be used to treat the pavement at the beginning of or in advance of a storm, if conditions for their use are favorable. The use of abrasives when chemicals will work encourages the formation of pack. The overall resource requirements for dealing with pack are far greater than preventing pack by the timely use of ice control chemicals.

5.4404 Materials Used for Ice Control

A. General

There are a large number of chemicals and other treatments that are used for ice control. NYSDOT generally uses six – salt (Sodium Chloride or Rock Salt), Treated Salt, Calcium Chloride, Magnesium Chloride, Magnesium Chloride with Organic Based Performance Enhancer and Abrasives (Sand). Most of the chemicals are available in the liquid form and can be used as part of an on-board wetting system with our spreaders or with slide-in tank and spray bar systems. They can also be use to pre-treat salt stock piles. The use of liquid chemicals in a slide-in- tank and spray bar system has several advantages over the use of solid chemicals. Liquids can usually be applied at relatively fast spreading speeds while achieving acceptable application patterns. Liquids also allow placement prior to a storm on dry pavement, but it has to be done on pavements above 20^{o} F. These are used singly or in combination depending on the climatological and pavement conditions. As newer ice control products become available they are carefully evaluated to see if they have a place in our ice control program.

B. Salt (Sodium Chloride or Rock Salt)

Salt is the most common and least expensive ice control chemical. The ability of salt to melt ice or form brine is highly temperature dependent. At 30^{o} Fahrenheit, one pound of salt will melt 46.3 pounds of ice. At 15^{o} Fahrenheit, one pound of salt will only melt 6.3 pounds of ice. This characteristic of salt primarily dictates when it is used and how much.

C. Treated Salt

As mentioned under Section A., salt can be pre-treated or pre-wet with a variety of liquids to improve its performance. Pre-treated salt will start to work quicker than untreated salt, will continue to perform at lower pavement temperatures, and can generally be applied at a lower application rate. The pre-treatment of salt also helps to reduce the "bounce and scatter" problems of untreated salt, thus keeping more material on the pavement. Salt can be purchased and delivered already treated by the vendor. Also a salt stockpile can be treated as it is being built or with an onboard wetting system. These two methods will be discussed in Section 5.4409.

D. Calcium Chloride

Calcium Chloride has much quicker low temperature ice melting characteristics than salt. As a liquid it can be used to pre-treat salt stockpile or sprayed onto salt in the spreader chute as part of an on-board wetting system. The ability to spray it onto the salt in the spreader gives the operator more flexibility to use the Calcium Chloride only when needed. When added to salt it improves the salt's melting characteristics at lower temperatures, accelerates the working time and reduces bounce and scatter. In the liquid form that New York States specifies, the Calcium Chloride is 32% by weight with an added corrosion inhibitor. As a solid material it may be mixed with salt for use at low temperatures or used straight to open drainage facilities.

E. Magnesium Chloride

Like Calcium Chloride, Magnesium Chloride has much quicker low temperature ice melting characteristics than salt. Magnesium Chloride is only used in a liquid form on both stockpiles of salt and in on-board wetting systems or slide-in tank and spray bar systems. New York State specifications require a 25% by weight of Magnesium Chloride in the product we purchase. This chemical also comes with a corrosion inhibitor.

F. Magnesium Chloride (w/ Organic Based Performance Enhancer (OBPE))

This material like Calcium Chloride and straight Magnesium Chloride has much quicker low temperature ice melting

characteristics than salt. Magnesium Chloride with OBPE comes in a liquid form and can be applied to both stockpiles and in on-board wetting systems or slide-in tank and spray bar systems. New York State specifications require a 13 - 26% by weight of Magnesium Chloride mix in the OBPE. The end product must have enough OBPE to produce a final material having a freezing point of -20^{o} F or lower. This product also comes with a corrosion inhibitor.

G. Abrasives (Sand)

Abrasives may be natural sand, manufactured sand, iron ore tailings, slag or lightweight aggregate conforming to New York State specifications**.** They provide immediate temporary improvement in the frictional characteristics of the pavement surface. While abrasives have a low initial cost, the cost per application is about the same as salt once the increased application rate, salt mixed in the stockpile and mixing costs are considered. The addition of after season clean up costs can dramatically increase the total cost of this product. Areas adjacent to certain bodies of water and certain aquatic creatures can be adversely affected by the use of abrasives.

5.4405 Guidelines for the Use of Salt

A. General Considerations

The effectiveness of salt is highly temperature dependent. Pavement Temperature is the key in this situation. Pavement temperature is seldom the same as air temperature. Starting about mid-morning, with solar warming, pavement temperature will exceed air temperature by as much as 40 degrees Fahrenheit. With nightfall, pavement temperatures will still be higher than air temperature for several hours. In early to mid-morning, pavement temperature will be lower than air temperature.

Absent the daily solar effects, seasonal geo-thermal factors do influence the relationship between air and pavement temperature. In early winter, pavement temperatures are generally warmer than air temperature. In late winter, pavement temperatures are generally colder that air temperature.

The ice content of a particular snow or ice event is another factor that influences the effectiveness of salt. There is a wide range in

the ice or water content of snow and ice events. The ice content of snow can vary from about 10% to 90%. Sleet, freezing rain, pack and glaze all have ice contents in the range of 90% to 100%. With increasing ice content per inch of snow or ice, more salt is required in order to be effective.

Salt is more effective with higher traffic volume. Frictional effects at the tire-pavement interface tend to warm the pavement. Also, the mechanical impact of traffic tends to break up the ice once the salt has prevented or broken ice/pavement bond. Given the above, reasonable judgment has to be exercised in deciding when to use salt and how much salt to use.

B. Specific Application Rate Guidelines

The Department's approach to ice control is proactive. Anti-icing is the preferred tactic to take, when appropriate. Appendix C contains general guidelines for anti – icing operation. The recommendations are in tabular form.

The use of these tables requires on knowledge of pavement temperatures and the ice bond characteristics prior to treatment. Application rates are shown for operations using untreated salt, treated salt and straight liquids. These application rates are based on several years of experience in New York and other States and are meant to be a guide. Experience of individual highways or network of highways will determine exact rates.

C. Accuracy of Application Rates

The application rates specified in Appendix C should serve as targets and actual application rates as determined from calibration data shall be within 7 ½ % of the target value. More information on calibration can be found in section 5.4412.

D. Spreading Patterns - Salt (Solid)

The spreading pattern is dictated by the type of highway, number of lanes being spread and the character of the event. Adjustments to spread pattern can be achieved by changing the spreader's baffle position, deflector position, spinner speed and direction of throw. Consideration needs to be given to the speed and volume of traffic on the highway being treated. Higher speed and volume highways will tend to spread material (liquid or solid) much quicker than on

corresponding lower speed and volume highways. For high volume highways, concentrated distribution of material should be considered. The most common cause of wider than desired spread patterns is excessive spinner speed.

1. Two Lane – Two Way Traffic

The most efficient pattern is to spread salt in about the middle third of the pavement. The normal pavement crown will allow salt brine to flow across the remainder of the pavement.

In simultaneous plowing/spreading operations the spread pattern should be within the recently plowed area to prevent working brine from being plowed off. On out-and-return beats, spreading should be limited to the lane being plowed.

In situations where the salt does not appear to be working well, the spread pattern may be further narrowed around the center line of the road.

2. Multi - Lane – One Way Traffic

Multi - lane highways usually carry heavier traffic volume. With the heavier volume, the spread pattern should be nearly full - width of the lane(s) being treated. If traffic volume is low or the salt does not appear to be working well, the salt should be distributed in relatively narrow bands around adjoining lane lines.

F. Spreading Speed

The traffic characteristics of the highway will to some extent determine the speed of the spreading truck. On high speed - high volume highways the speed will be faster than on low speed - low volume highways.

With increasing speed, “bounce” and “scatter” of salt becomes greater. Treating salt as it leaves the hopper with an on board wetting system or using pre-treated salt reduces the “bounce” and “scatter of the salt. The actual speed pattern should be checked periodically to be sure the salt is being distributed as intended.

Depending on the road and traffic condition, speeds should be in the range of 15 MPH to 35 MPH.

5.4406 Guidelines for the Use of Abrasives

A. General Considerations

Abrasives should generally be used where low traffic volume and/or low temperatures will preclude chemicals from working properly.

Abrasives may be used initially in some circumstances where chemicals will work. These include steep grades and other situations where the normal working time associated with chemicals could result in road blockage caused by vehicles stranded due to lack of traction.

The use of "sweetened" mixtures like 50-50 (1 part abrasives and 1 part salt) is wasteful and inefficient. If spread at the normal application rate for abrasives, this mixture will place 40% more salt on the road than a normal application of straight salt. The effectiveness of that salt is reduced by the presence of the abrasives.

Although snow and ice surfaces that have been treated with abrasives are safer than untreated snow or ice surfaces, they are not as safe as bare pavement. Traffic quickly diminishes the effect of abrasives and frequent re-application is necessary. This adds significantly to the overall cost and still provides a less safe surface than the bare pavement that could have been achieved with pure chemicals.

B. Specific Abrasives Application Rate Guidelines

Abrasives (as specified in the New York State Department of Transportation specification No. 96-1, issued July 8, 1996, See Appendix D) shall be applied at 750 pounds of abrasives per mile, per lane**.** This rate may be increased by up to 20% for hills, curves and intersections and decreased by up to 20% for tangent (straight) sections (600 – 900 lbs./lm.).

C. Accuracy of Application Rate

The actual application rate as determined from calibration data shall be within 7 ½ % of the target value. More information on calibration can be found in section 5.4412.

D. Spreading Pattern

Abrasives shall be spread as near to full pavement or lane width as possible.

E. Spreading Speed

The spreading speed should be in the range of about 15 to 30 MPH, depending on traffic and highway surface conditions.

5.4407 Mixing Salt with Abrasives

A. General

A small amount of salt must be added to abrasives in order to keep them in workable or spreadable condition and have them adhere to the snow or ice. The amount necessary will vary with the normal winter temperature of the area. For most of the State, 5% salt is sufficient. In normally colder areas, 10% salt may be necessary. In milder areas as little as 2 ½% salt will be satisfactory.

B. Density of Abrasives and Salt

For computation purposes, the following uncompacted densities are considered standard or average:

Material	Density, lbs/ yd^3
Salt	2,000
Sand	2,700

For abrasives having densities significantly different from those listed above, the application rate may be adjusted to yield the same volume of abrasives applied to the highway.

C. Guidelines for Mixing Salt with Abrasives

Using the densities in B. above, the following is a guide for mixing abrasives with salt:

	Number of Buckets	
% Salt	Sand	Salt
2.5	30	1
5.0	15	1
7.5	10	1
10.0	8	1

5.4408 Procurement and Quality of Abrasives

A. Procurement of Abrasives

Unless an in-house abrasives mine is available, abrasives should be procured through the competitive bidding process. The contract should be for abrasives delivered to the stockpile site. Studies have determined this is the more cost effective approach than having users pick up the material F.O.B. mine.

B. Quality of Abrasives

Abrasives should be comprised of granular material that is relatively free of organic impurities. The grain size distribution is important as it influences workability and the amount of salt that must be added to keep the abrasives spreadable. Gradation requirements vary around the state depending on the product availability. Gradation information can be found in the New York State Department of Transportation specification No. 96-1, issued July 8, 1996. A copy can be found in Appendix D.

Particles passing the # 50 sieve do not have much abrasive quality and particles passing the # 200 sieve have a detrimental effect on spreadability and storability.

Particle shape is also important. Abrasives containing substantial amount of flat and/or elongated particles do not store and spread well.

5.4409 Guidelines for Pre – Wetting Salt

A. General Considerations

Liquid de-icers such as Calcium Chloride, Magnesium Chloride, or Magnesium Chloride with Organic Based Enhancers are added to salt to improve low temperature characteristics, reduce bounce and scatter and accelerate working time. Salt treated with these chemicals should not be used on pavement temperatures above 20^{o} F unless there is a special need to accelerate working time or penetrate pack. If salt is treated with these liquids, the application rates can be reduced as shown in Appendix C.

B. Mixing and Application Rate Guidelines

There are two systems used by NYSDOT for adding liquid de-icers to salt. As a stockpile of salt is being prepared it can be mixed with any of the liquid de-icers mentioned in Section A. The spinner spray system sprays the liquid de-icers onto the salt after it comes out of the spreader and before it reaches the spinner.

Mixing rates for the two systems are:

System	Gals. Of Liquid De-icer Per Ton of Salt
Stockpile	8
Spinner Spray	6

These are recommended rates to start. These rates may need to be adjusted as conditions warrant.

The application rates for salt treated with liquid de-icers are less than those for straight salt. Refer to Appendix C for the appropriate rates.

Caution with late-in-the-day application is necessary in post – storm conditions. There is a tendency for water/brine to re-freeze at night if traffic does not dry the pavement.

5.4410 Guidelines for Anti-icing with Liquids

A. General Considerations

Liquid deicing chemicals can be applied directly to pavement utilizing an adequately sized slide in tank or tanker truck with a spray bar. This process can be used to pre-treat pavement or bridge decks and other icing prone locations in advance of a storm anywhere from several hours to several days in advance of the event. Under certain conditions liquids may be applied during a storm. When using liquid chemicals in this type of application, do not apply to pavements below 20^0 F. Refer to the application tables in Appendix C, page C-9 for more detailed information.

Liquid Calcium Chloride is not the most desirable choice for the pre-treatment of pavement. Due to problems with this chemical leaving pavement slippery under certain conditions, caution must be exercised if this chemical is used. Special care is necessary to not over apply, maintain effective spray pattern, and monitor pavement temperatures to ensure that the material will dry quickly. Magnesium Chloride with or without Organic Based Enhancers and Salt Brine are more desirable products for use in the pre-treatment of pavements

B. Spreading Patterns - Liquids

Currently most of the NYSDOT equipment consists of a 700 gallon slide in tank with a spray bar mounted in a small dump truck. Liquid chemicals should be distributed on the pavement using streamer or pencil nozzles that lay strips of chemical about 10 inches apart, leaving untreated pavement between the strips. With salt brine, this method or a fan spray type of applicator may be used. While these units have the capability to spray multiple lanes, best results have been achieved by spraying one lane at a time.

C. Spreading Speed

For straight liquid applications spreading speeds can be between 40 MPH and 50 MPH on dry pavements when doing pre-treatment applications. When spraying during a storm, speeds will be lower based on conditions.

5.4411 Special Considerations in Ice Control

A. General

Good judgment in the application of chemicals is a must. Chemicals can be very effective under certain apparently adverse conditions or they may be very dangerous under some seemingly ideal conditions.

B. Time of Day

The time of day when chemicals are applied can greatly affect the action of that chemical. Spreading the appropriate material prior to the morning and afternoon commuter hours allows the material to work with the heavy traffic volumes to help break up any snow or ice on the road and get a brine solution started. Care must be given to watch pavement temperatures when they start to fall, which may increase the potential for re-freeze. Refer to your application tables in Appendix B for appropriate action as pavement temperatures fall.

C. Traffic Volume

The traffic volume greatly affects chemical action. Also, heavy traffic during the mid-part of the day may whip slush from the pavement, leaving it dry. On lightly traveled roads, traffic may only rut the slush, leaving it to freeze as temperatures drop at night, unless the slush is plowed off.

D. The No Treatment Situation

Chemicals or abrasives should not be applied in conjunction with plowing operations at very low temperatures or when plowing blowing and drifting snow at very low temperatures. Usually snow will not bond to the pavement and can be effectively removed by plowing. Traffic will whip the rest of the snow away. In this situation chemicals, or the salt in abrasives, may make the snow stick to the pavement causing icy spots. Pavement must be monitored closely to ensure that chemical treatment of the pavement can begin when needed.

E. Spot Treatments

In situations where conditions are present that require intermittent (spot) treatment (pavement of bridge icing potential, blow-overs, drifting or other snow and ice conditions that do not effect the entire State Highway system in a given area) it is recommended that only a portion of the "normal" response capability be utilized during this activity. The activity is called spot treatment.

F. Treatment of Drifts and Blow-Overs

Drifting areas are defined as those locations on the highway system where significant quantities of snow can accumulate due to blowing snow, to the point where a lane or the entire highway may become impassable to vehicle traffic. These locations are usually found in cut sections and other areas having features that promote the accumulation of snow on the highway. Blow-overs occur along numerous locations on the highway system where wind occasionally blows snow across the highway and may accumulate to a few inches. However, lane or roadway closure is less likely in blow-over situations. This situation may occur adjacent to large open areas on the upwind side of the highway associated with drifts and blow-over areas. It is impractical to use passive snow control measures to control blowing snow in blow-over areas. Because of the large number of locations and the unpredictability of wind patterns, blow-overs can occur in any location where there are open upwind areas, sufficient wind velocity and transportable snow. Passive control measures should only be considered where there is sufficient accident history associated with the blow-over location. The Regional Traffic Safety Operations Group can assist in identifying these locations.

The cyclical treatment of active drift and blow-over areas by periodic plowing and treatment with ice control chemicals, as necessary, (See D. above) is the control method of choice if bonding to the pavement has begun or is likely. However, plowing and periodic treatment with abrasives/chemical mixtures may be used as long as there is sufficient chemical in the mixture to prevent ice/pavement bond. After blowing ceases, treatment will depend on the road and weather conditions of the moment.

G. Hard Pack

Hard Pack 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. Our anti-icing procedures usually prevent this condition, but occasionally pack is formed and must be removed.

With the exception of thin pack, removal is best done by mechanical methods, since the required amount of salt needed to melt the pack is not practical. A grader with or without ice blades is the best equipment for the job. In some cases, underbody blades and plows will work. The ideal time to remove pack is after the storm when the sun is out, however, other factors such as heavily traveled commuter routes may make it necessary to work on it at night. The recommended procedure is to apply a heavy application (360 lbs./lm. +/-) of pre-wetted salt. Pre-wetted salt tends to eat through the pack and with time will break the bond at the pavement surface, allowing mechanical removal. On thin pack, the application of pre-wet salt is usually sufficient and any slush can be plowed off. Dry solid salt can be used if pre-wet salt is unavailable. Liquid ice control chemicals are an excellent treatment for very thin ice, black ice and frost.

5.4412 Spreading Equipment and Calibration

A. Spreading Equipment

Most spreading is accomplished with "V" box spreaders that mount in the box of heavy dump trucks. In recent years we have added to our fleet, large dump trucks that have built in spreaders. The spinners can be mounted on either the right or left side of the truck in front of the rear wheels or at the back of the truck. Their capacity is similar to the "V" box spreaders. There are three different capacity "V" box spreaders in common use. The capacity and approximate range are listed below:

Spreader Capacity	Range (lane – miles)	
Cubic Yards	Salt	Abrasives
6	53	18 – 26
7	62	20 – 30
10	89	29 – 43

These ranges depend on application rates and for abrasives the proportion of hills, curves and intersections.

B. Ground Speed Controllers

Systems that automatically change application rate with change in ground speed should be operational on all spreader trucks. These systems are relatively inexpensive and can pay for themselves in materials savings in a short period of time.

C. Calibration of Spreaders

All spreaders and ground speed controllers should be calibrated each year prior to the snow and ice season and after major repair on the spreader. There are separate calibrations for salt, mixes of liquids with salt and abrasives. Detailed calibration procedures for each type of spreader are available from the NYSDOT Office of Operations Management.

D. Back-up Calibration for Non-Automated Spreading

In addition to the calibration described in C. above, each spreader/truck should have established a back-up calibration to be used when the automatic system is not functioning. The details of this procedure are available from the NYSDOT Office of Operations Management.

5.5000 Stockpiling and Storing Chemicals and Abrasives

5.5100 Objective

The objective of providing stocks of chemicals and abrasives is to have these materials available and ready for use at locations tofacilitate a reasonable response time to snow and ice events.

5.5200 Goal

The goal of stockpiling and storing chemicals and abrasives is to assure an adequate supply of these necessary materials throughout the snow and ice season while minimizing adverse effects on the environment.

5. 5300 Methodology

5.5301 Sites for Stockpiling and Storing Chemicals and Abrasives

A. Preliminary Investigation

Prior to locating stockpile and storage areas, a check should be made of local ordinances for storage requirements. In addition, a check should be made of watershed rules and regulations made or approved by the New York State Department of Health (Section 1100 of the New York State Public Health Law) or other Regulatory Agencies for compliance purposes. NYSDOT Environmental Analysis Bureau personnel can assist in researching appropriate rules and regulations. Information about storage facilities can be found in the Department's Environmental Handbook for Transportation Operations. Sites should be selected to minimize "dead-heading". They should also be centrally located as possible. This will minimize the number of sites required. Joint stockpiles or reciprocal agreements can be made with other agencies (e.g., County or Town Highway Departments) to minimize duplication of facilities and reduce the cost of loading equipment. This necessitates close cooperation and accounting with the other agency(s) involved.

B. Site Characteristics

1. Highway Access

Since trucks and other equipment will be using stockpile and storage sites during storms and at times of poor visibility, they should be easily accessible. Access roads to the site, where possible, should not open directly onto heavily traveled highways and should be located to provide ample sight distance for the equipment operators. The Regional Traffic and Safety Group should be contacted to determine if Truck Entering warning signs should be erected.

2. Drainage

Sites should be selected or graded to provide positive drainage away from the stockpile or storage facility. The area selected should not drain directly into a stream, reservoir, well, well aquifer, or adjacent occupied property.

3. Size

Storage areas should be large enough for front-end loaders and trucks to maneuver safely.

4. Doors to Buildings

Building doors and other openings should be large enough to permit access for loading and unloading.

5. Driveway Access

The surface of the driveway and maneuver area should be paved such that there are no low or weak spots.

6. Access Platform and Loading Ramps

Access platforms and loading ramps should be provided to make loading operations safer.

7. Lighting

Yard areas should be adequately lighted and lights should also be available inside the storage buildings. Lighting should be checked prior to the beginning of the snow and ice season to ensure all are in working order.

8. Ventilation

Storage buildings should have positive ventilation to allow exhaust fumes from the equipment to safely ventilate to the outside. Trapped fumes can create a health hazard to the operators. Prior to the beginning of the snow and ice season, buildings with fans should be checked to ensure they are in working order.

9. Housekeeping

All work areas should be as unobtrusive as possible. They should be kept neat and orderly. Screening with trees and shrubs makes the area more aesthetically appealing. After every storm, loose material around loading ramps, storage buildings, etc. should be gathered up and returned to the stockpile or storage building.

5.5302 Guidelines for Storing Salt

All straight or treated salt shall be stored, covered and housed on an impermeable pad in an acceptable structure. Where acceptable structures are not available or there is insufficient storage capacity in structures, pure or treated salt shall be stored on impermeable pads and covered with secured waterproof tarpaulins, year round.

5.5303 Guidelines for Storing Liquid Chemicals

Liquid chemicals shall all be stored in non-reactive containers, protected from vehicular traffic. It is strongly encouraged that the Resident Engineer develop a plan to provide for secondary containment features for any storage tanks. These features can be part of an overall facility plan to control site runoff. All recommended handling procedures found in the manufacturer's Material Safety Data Sheet shall be followed. The containers, piping and pump systems should be inspected periodically for leaks. If any leaks are found they are to be treated as outlined in Appendix B.

5.5304 Guidelines for Storing Abrasives that Contain Chemicals

All stockpiles of abrasives containing chemicals shall be placed on an impermeable asphalt concrete pad (having an impermeable membrane) and be completely enclosed in: (1) A structure that effectively keeps rain and snow off the abrasives, or, (2) waterproof tarpaulins that are effectively secured. This requirement is effective year – round.

There are two exceptions to this policy:

A. Small working piles of abrasives containing chemicals may remain uncovered during the winter season as long as they are on an impermeable pad and have a berm of untreated abrasives around the stockpile and within the confines of the impermeable pad. At the end of the winter all abrasives on the pad (including the berm) shall be mixed together and moved within an appropriate structure or securely covered with a waterproof tarpaulin on an impermeable pad.

B. During the colder portions of the winter, the working face of untreated abrasives stockpiles may have a small amount of chemical mixed in the topmost portion. However, the working face must be protected by a small containment berm of untreated

abrasives. As with A. above, at the end of the winter, any abrasives containing chemicals must be removed and stored in appropriate structure or securely covered with a waterproof tarpaulin on an impermeable pad.

If stockpiles are to be covered with tarpaulins, low, elongated shaped piles are much easier to manage. Old guiderail installed on either side of an elongated pile provides excellent lashing points to secure the tarpaulins.

5.5305 Guidelinesfor Managing Untreated Stockpiles of Abrasives

Untreated stockpiles of abrasives having the proper grain size distribution can be effectively managed. This is usually done in conjunction with mix-and-go (mixing chemical with abrasives and immediately loading the spreading truck) operations or where small amounts of abrasives containing chemical are stored in a structure or in a small covered stockpile. There are some techniques that facilitate the management of untreated stockpiles of abrasives:

A. There must be sufficient extra material to compensate for the material that will become frozen into chunks and be unusable during the colder portions of the winter. A frozen chunk factor of about 20% is an average condition for most or the State.

B. Build the stockpile relatively low so the loading equipment can safely remove bridges and overhangs of frozen material that form on top of the working area.

C. Orient the working face of the stockpile to face the south. This will take a maximum advantage of solar heat and reduce the severity of frozen material on the working face.

D. Obtain abrasives that have:

1. Smaller proportion of minus #50 sieve size particles.

2. A small proportion of particles having flat or elongated shapes.

E. Mixing chemicals with abrasives at the working face of the untreated stockpile and removing the mixed material to smaller working piles or structural shelter has proven to be effective.

F. Utilize sunny days to the extent possible when mixing chemical with abrasives.

G. Backblading with loaders or dozers can sometimes break up frozen chunks of abrasives.

5.5306 Stockpiling and Mixing Salt Chemical with Abrasives

Abrasives are usually delivered to the site in dump trucks. Depending on management strategy, chemicals may or may not be mixed with abrasives during the stockpiling process.

A. Conveyors

Conveyors are the most efficient type of equipment for creating uncompacted stockpiles. If chemicals are being added to the stockpile, a second conveyor for chemicals will provide a well-mixed stockpile.

B. Cranes

Cranes with clamshell buckets may be used for creating both chemically treated and untreated stockpiles of abrasives. They are capable of creating reasonably well mixed uncompacted piles of treated material. However, they are not capable of a high rate of production and the stockpiling process could be lengthy and costly.

C. Other Equipment

Loaders, dozers, hydraulic excavators, power shovels and even trucks may be used singly or in combination to create stockpiles. None of these methods are capable of efficient mixing and most will produce a compact stockpile. However, in most cases, stockpiling must be accomplished with the available equipment, and these types of equipment are frequently used. Care must be exercised when utilizing trucks, loaders and dozers on inclined surfaces. If not utilized properly, this equipment could easily tip over during the stockpiling operation. Hydraulic excavators and power shovels should always operate from a flat surface.

5.6000 Snow Stake Installation

5.6100 Objective

The objective of snow stake installation is to identify possible obstructions within the plowing and winging area that may interfere with the snow removal process.

5.6200 Goal

Install snow stakes at locations of possible obstructions within the plowing and winging area that may interfere with the snow removal process.

5.6300 Methodology

A. Timing

Snow stakes that must be driven into the ground should be installed before the ground freezes and well in advance of the first anticipated snowfall.

B. Materials

Material for snow stakes may vary from wooden stakes to delineator posts. Uniformity of material is desirable and the type of material used should reflect the class of highway.

C. Functional Characteristics

Snow stakes should be long enough to extend above the anticipated depth of snow in the area. The top six inches of the stake should be painted, flagged, taped, or have an appropriate colored delineator in place, to provide better visibility.

D. Obstructions that Should have Snow Stakes

Generally, all solid objects within the plowing and winging area that are likely to be covered with snow, should be identified by snow stakes. These include, but are not limited to: Guide posts, ends of guide rail runs, culvert headwalls, traffic canalization devices, hydrants, gutters and isolated curb sections.

E. Snow Stakes to Identify Drainage Features

Catch basins, drop inlets and other drainage structures, particularly in median areas, should be marked with snow stakes to permit location of the structures when it is snow covered. In urban areas a painted arrow in the middle of the curb lane helps to locate these types of structures.

F. Snow Stakes Used as Shoulder and Median Markers

On divided highways snow stakes should be used to delineate the shoulder and median area. The stakes should be about 5 feet above the ground and be placed 1 to 2 feet beyond the shoulder. Spacing on tangent sections should be 200 feet. Closer spacing on curves may be utilized. When snow stake median markers are

used in conjunction with permanent delineators on the right shoulder, they should be placed directly opposite every other (alternate) permanent right shoulder delineator post.

5.7000 Maintaining the Capability of Drainage Features

5.7100 Objective

The objective of maintaining critical drainage features is to minimize flooding during thaw conditions.

5.7200 Goal

Maintain the functional capability of critical drainage features so that flooding and ponding on the highway are minimized during periods of thaw.

5.7300 Methodology

A. General

Through knowledge and experience, the critical drainage features should have been identified. It is important to maintain their functionality throughout the snow and ice season.

B. Closed Drainage Systems

In order to maintain safe roadways and protect against flooding and freezeovers, the top of catch basins and drop inlets should be cleared of snow and provided with reasonable means to prevent possible development of ice. If a system is likely to freeze up, chemicals should be applied periodically to critical catch basins and drop inlets, subject to existing conditions in the area involved.

C. Open Drainage Systems

Prior to thaws and the subsequent runoff, it is advisable to remove packed snow and ice from the ends of culverts and their inlet and outlet ditches. At the beginning or middle of the winter, if water is flowing adequately underneath the snow, the snow should not be removed since this might allow the water to freeze and block the culvert. As the weather moderates and a continued thaw is anticipated, the snow and ice should be removed as indicated above. Weather forecasts will aid in making the decision whether or not to remove the snow. Generally, a forecast of two or more days of thaw indicates need for snow removal at known locations.

D. Structures

Finger joints, expansion joints and the bridge deck drainage systems should be kept functional during the winter. Removal of surface snow and ice and the thawing of drainage and expansion features with chemicals may be necessary.

E. Thawing Drainage Structures

Frozen drainage features are usually cleared by adding liberal amounts of chemicals to the upstream frozen surface subject to existing conditions in the area involved. A Steam Jenny may also be used if available and deemed reasonably effective given existing conditions in the area involved and can be used from both upstream and downstream sides of the frozen location. The steam approach is more environmentally sound and should be used to the extent possible.

5.8000 Passive Snow Control

5.8100 Objective

The objective of passive snow control is to reduce or eliminate persistent snow drifting on roadways to improve visibility during blowing snow conditions by installing snow fence, planting shelterbelts, or altering the roadway cross section.

5.8200 Goal

The goal of passive snow control is to reduce or eliminate areas of persistent drifting and/or low visibility where resources, right-of-way and cost effectiveness will permit.

5.8300 Methodology

5.8301 General

Use of passive snow control techniques will improve roadway safety and reduce supplementary snow removal in areas of recurrent drifting. The erection of snow fence or the establishment of shelterbelts in areas of frequent drifting and/or whiteouts can dramatically improve or eliminate the condition. Drifting problems may also be mitigated by reconstructing the roadway cross section to provide a windswept aerodynamic cross sections which will remain drift free. Partial improvement should be considered at locations where total mitigation measures are not possible. Additional information on passive snow control can be found in the Department's Highway Design Manual, – Chapter 5.

5.8302 Snow Fence

Snow fences may be permanent or temporary. Permanent fences erected on private property will require the acquisition of a permanent easement. The Regional Real Estate Officer should be contacted for easement procedures. Temporary fences may be erected on private property under Article 3, Section 45 of the Highway Law.

Snow fences should be of adequate height to store the usual expected amount of snow that will be transported (blown) through the location. The snow transport will vary by location. The Regional Design Group may be consulted for an accurate estimate of this snow transport. The required fence height is given by **H** in the following equation:

$\mathbf{H} = 0.065\ (Q^{0.454})$, where Q = average snow transport (lbs.)

The length of the upwind drift created by a snow fence is equal to 15 x height. The downwind drift length is equal to 35 x height. For this reason, snow fences should be placed at a distance of 35 x height from the road to ensure that the drift generated by the fence will not encroach onto the roadway. The fence may be placed closer to the road only if there are topographic features, such as a ravine, which will provide significant additional storage. If the fence becomes full during most winters, the height should be increased and the distance from the highway adjusted accordingly. Although additional rows of fence will increase the amount of available snow storage, it is much more cost effective to increase the height and use a single fence. Fence heights should generally exceed six (6) feet except in limited areas. Fences should have a gap ratio of 50%.

All fences should have a gap at the bottom to prevent the fence from becoming buried. The gap should be 10% of the total fence height and should be measured from the top of the expected winter vegetation. Fences should be oriented parallel to the road except when the prevailing wind direction is more than 30 degrees from the perpendicular to the road.

Fences should be extended a distance of 50 feet beyond the area to be protected to prevent snow from being blown around the ends.

5.8303 Shelterbelts (Living Snow Fences)

Also referred to as “living snow fences”, shelterbelts are multiple rows of trees, preservation of agricultural crops, or shrubs planted to provide protection from wind-driven snow. There are many advantages to shelterbelts as compared to snow fences, including roadside beautification, wildlife benefits, little or no maintenance after establishment, and long service life. The Regional Landscape

Architect and Maintenance Environmental Coordinator should be consulted whenever shelterbelts are considered.

Some design tips for planting shelterbelts are:

- Trees should be placed no closer than 3 times their mature height from the edge of the shoulder.
- Generally, trees should be coniferous. Shrubs may be effective in areas of limited blowing and drifting snow.
- Two or more staggered rows should be planted to provide full coverage and to prevent gaps caused by plant loss or damage.
- Trees should be spaced so that crown closure will be achieved within ten years.
- An effective shelterbelt can be achieved by requesting farmers to leave six to eight rows of corn stalks standing through the winter. The minimum setback from the road shoulder should be 35 times the effective stalk height (height minus ambient snow depth).

This may be accomplished by using appropriate real estate procedures of the NYSDOT Real Estate Division.

5.8304 Modifications of Roadway Features

Providing an aerodynamic cross section will allow the roadway to be swept clear by the wind. It should be recognized that this is not a solution where whiteouts are a problem. In some areas it may be possible to alter the cross section to provide for additional snow storage upwind from the road. Minor grading on private property may be accomplished with appropriate real property procedures. The details of these procedures are available from the NYSDOT Real Estate Division.

The following guidelines will improve drift prone areas:

- Back and fore slopes should be flattened to a 1:6 slope or flatter.
- Ditches should be widened as much as possible.
- The profile of the road should be raised to two feet above the ambient snow cover.
- Provide a ditch adequate for storing the snow plowed off the roadway.
- Widen cuts to allow for increased snow storage.
- Eliminate the need for guiderail.

5.9000 Municipal Snow & Ice Contracts

5.9100 Objective

The objective of municipal Snow & Ice contracts is to provide the traveling public with a passable highway as much of the time as possible – given the constraints of operational resources and the character of the snow or ice event.

5.9200 Goal

The goal is to have properly executed contracts in place prior to the beginning of each snow and ice season. These contracts are to ensure that a municipality is able to provide adequate response to snow and ice work on our highways.

5.9300 Methodology

Municipal contracts are a means by which the Department of Transportation has municipalities perform the full range of snow and ice control activities on sections of the State Highway System. These contracts require municipal contractors to perform snow and ice activities as outlined in this document. Administration of the contracts is covered in the Department of Transportation's publication Municipal – State Agreements for Control of Snow and Ice on State Highways: Terms, Reimbursement Procedures and Documentation, dated December 1999.

APPENDIX A

OPERATIONAL PLAN OUTLINE

April, 2006 (Revised January 2012)

OPERATIONAL PLAN OUTLINE

REQUIRED INFORMATION:

- Staffing Distribution
- Equipment Distribution
- Equipment Calibration
- Beat Descriptions
  - Written Description
  - Length of the Beat in Lane Miles
  - Typical Cycle Time
  - Typical Application Rates and amounts of the various materials required for the beat
  - Maps of the Beats
- Storm Manager Procedures
- Radio Watch Procedures
- Crossovers Used as Turnarounds
- After Storm Cleanup Procedures
- Approved Snow Disposal Sites
- Municipal Contracts
  - Routes
  - Contacts
  - Contact Information (chain of command, phone numbers, etc.)

SUGGESTED INFORMATION:

- Main Office, Regional Office and Residency Snow & Ice Policies
- Any Other Pertinent Information

APPENDIX B

DEFINITIONS, HANDLING CHEMICALS & EQUIPMENT CHECKLIST

SNOW & ICE CONTROL DEFINITIONS

Benching of Shelving	Using a wing plow to displace the top portion of snow berms adjacent to the pavement or shoulder.
Berm or Windrow	A linear accumulation of snow cast by a plow, or other equipment, or wind.
Close Echelon	Snowplows in adjacent lanes working in a tight plowing group that do not permit traffic to pass between them.
One Way Plow	This is a plow mounted on the front of a truck that can cast snow only in one direction. Usually the snow is cast to the right.
Plow Angle of Attack	The angle (less than 90^{o}) formed in plan view where the plow blade face deviates from a 0^{o} set position which is parallel to the front grill of the plow truck.
Plowable Snow	Generally, accumulation of greater than ½ inch to 1 inch of snow.
Reversible Plow	This is a plow mounted on the front of a truck that can cast snow to either the right or left depending on the angel of attack of the plow.
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 plows, loaders or snow blowers.
Tandem Plowing	Snowplows working in groups having sufficient space (a minimum of 1000 feet or about the distance between two reference markers) between them for traffic to pass.
Wing Plow	A plow mounted on either the left or right side of a truck, which in combination with a One Way or Reversible plow casts snow off of paved surfaces.

SUMMER STORAGE OF ON-BOARD WETTING SYSTEMS

It is important to properly store On-Board Wetting Systems to ensure their availability for the next Snow and Ice Season. Improper storage can lead major damage. The following are the recommended procedures for storing these units:

Empty the saddle tank(s) into the bulk storage tank.

The pump should be flushed with a solution of warm water and then windshield washer fluid. The washer fluid will prevent any residual water from freezing prior to the next spreading season.

When connecting and disconnecting electrical plugs, treatment with electrical spray or dielectric grease (for use with electrical equipment) is recommended to prevent corrosion and protect from intrusion of water.

All exterior surfaces should be thoroughly rinsed off with water to lessen the possibility of corrosion.

The system should be visually inspected for wear or other problems prior to storing for the summer. Any necessary repairs should be documented and brought to the attention of the Equipment Management Mechanic.

SUMMER STORAGE OF BULK STORAGE TANKS

As with the truck mounted on board systems, several areas of the bulk storage tanks need to be addressed.

The pump should be disconnected and then flushed with a solution of warm water and then windshield washer fluid. The windshield washer fluid will prevent any residual water from freezing prior to the next spreading season.

Electrical connections should be checked for wear. Any electrical plugs should be treated with electrical spray or dielectric grease to prevent corrosion and protect from intrusion of water.

Hose and pipe connections to and from the pump should be inspected for wear and repaired or replaced as appropriate.

It is recommended that de-icing liquids in bulk storage tanks be re-circulated (agitated) every two weeks during extended periods of non-use.

NYSDOT SAFETY GUIDELINES FOR HANDLING OF LIQUID CHEMICAL DE-ICERS

Personal Protective Equipment (PPE) must be worn when handling these materials. As a minimum, PPE gear includes splash goggles, face shield, rubber gloves and rubber boots. A copy of the Material Safety Data Sheet (MSDS), for each chemical used, shall be readily available at every work site where these chemicals are being used. The MSDS will give further guidance on PPE requirements.

Keep a one liter eyewash bottle on hand during the entire filling operation.

Avoid contact with skin and leather apparel (boots, gloves, etc.)

Prior to pumping check all hoses and piping to insure secure connections and sound hoses.

Prior to and at the end of pumping, check valve settings to insure proper flow control.

While pumping, stand clear of hose and pipe connection points.

Visually monitor tank filling to avoid overfilling.

When filling is complete shut off pump, check valve settings, disconnect and store fill hose properly (e.g. return to hose rack).

FIRST AID MEASURES

EYES:	Flush promptly with plenty of water continuing for at least 15 minutes. GET MEDICAL ATTENTION!!!
SKIN:	Wash with plenty of water.
INHALATION:	Remove to fresh air (for cases of airborne mist and dust)
INGESTION:	Contact Poison Control and/or refer to MSDS sheets for ingestion instructions.

NYSDOT SAFETY GUIDELINES FOR RESPONDING TO LIQUID CHEMICAL DE-ICER SPILLS

Minor Spills (Less than 20 Gallons)

Put on appropriate Personal Protective Equipment (PPE) (splash goggles, face shield, rubber gloves and rubber boots).

If possible, safely stop the source of the spill (e.g. shut off pump, close valve, etc.).

Notify shift supervisor.

Contain spill with sand.

Spread sand to absorb the liquid chemical de-icer.

Collect saturated sand and stockpile separately.

If possible, cover stockpile with a waterproof covering.

When operation is completed, wash down all equipment used.

Major Spills (Greater than 20 Gallons)

Put on appropriate PPE (splash goggles, face shield, rubber gloves, and rubber boots).

If possible, safely stop the source of the spill (e.g. shut off pump, close valve, etc.)

Notify the shift supervisor and Resident Engineer.

Contain spill with sand.

If full containment is not possible, dilute liquid chemical de-icer runoff with large volumes of water (control subsequent icing problems, if required)

Spread sand to absorb contained liquid chemical de-icer.

Collect saturated sand and stockpile separately.

If possible, cover stockpile with a waterproof covering.

When operation is completed, wash down all equipment used.

TRUCK CHECK SHEET (WINTER SEASON)

Truck ID: _____ Date: _____

Unload and Wash Hopper/Combo	_____	Time: _____
Wash Truck	_____	Mileage: _____
Refuel	_____	Operator: _____
Lube Chassis	_____	

Interior	Checked	SDR/VTR
1. Head Lights	1._____	_____
2. All Exterior Spot Lights	2._____	_____
3. Revolving Lights	3._____	_____
4. Hopper Lights (Spot & Warning)	4._____	_____
5. Reverse Lights	5._____	_____
6. Directional Lights/4-Way Flashers	6._____	_____
7. Brake Lights	7._____	_____
8. Wipers, Washer	8._____	_____
9. Defrost/Heater	9._____	_____
10. 2- Way Radio	10._____	_____
11. Dickey John Operation	11._____	_____
12. Levers & Pins	12._____	_____
13. Clutch Free Play (1.5”), Steering. And Brake Operation	13._____	_____
14. First Aid Kit, Fire Extinguisher, Triangles	14._____	_____
15. Mirrors, Mirror Heaters, All Gauges, All Glass	15._____	_____
16. Clean Cab (Litter, Projectiles/Objects, etc.)	16._____	_____
17. Seats and Seat Belts	17._____	_____
18. Copy of Overwidth Permit & Accident Reporting Forms (Glove Box)	18._____	_____

Under Hood		
19. Engine Oil (15w40)	19._____	_____
20. Anti Freeze	20._____	_____
21. Power Steering Fluid	21._____	_____
22. Window Washer Fluid	22._____	_____
23. Hoses and Belts	23._____	_____
24. Check for Leaks	24._____	_____

Exterior: Left Side		
25. Duals (Condition, PSI, Spun, Lug Torque (230 spoke, 450 bud))	25._____	_____
26. Hydraulic Fluid (5w20)	26._____	_____
27. Hopper: Hoses, Fittings, Tie downs, Electric Connections	27._____	_____
28. Hopper: Tie Downs and Flaps	28._____	_____
29. Combo Body: Front discharge spinner, gate setting, etc.	29._____	_____
30. Cab Steps and Grab Bar	30._____	_____
31. Front Tire (Condition, PSI, Spun, Lug Torque (230 spoke, 450 bud)	31._____	_____
32. Hub Oil Level (90w mineral oil)	32._____	_____
33. Block Heater and Cord	33._____	_____
34. Left Front Leaf Springs	34._____	_____
35. Operate Tail Gate Latch Several Times (Be sure to secure afterwards)	35._____	_____

Exterior: Left Wing		
36. Overall Condition	36._____	_____
37. Cables, Clamps and wing cylinder hose’s (For Damage & Rust)	37._____	_____
38. Wing Braces, Tension Springs, Shear Pins and Bolts	38._____	_____
39. Clevis Pins and Bolts	39._____	_____
40. Cutting Edges, Curb Runner, Bolts	40._____	_____
41. D-Block Assembly	41._____	_____
42. Wing Marker	42._____	_____

	Checked	SDR/VTR
Exterior: Front Plow		
43. Overall Condition	43._____	_____
44. Cutting Edge	44._____	_____
45. Shoes	45._____	_____
46. Plow Springs	46._____	_____
47. Lifting Chains	47._____	_____
48. Push Pins, Cotter Keys	48._____	_____
49. Plow Markers	49._____	_____
50. Hoses	50._____	_____
51. PTO Drop Box Oil Level (90w mineral oil)	51._____	_____
52. Push Frames, Braces (For cracks and/or Damage)	52._____	_____
Exterior: Right Wing		
53. Overall Condition	53._____	_____
54. Cables and Cable Clamps (For Damage & Rust)	54._____	_____
55. Wing Braces, Tension Springs, Shear Pins and Bolts	55._____	_____
56. Clevis Pins and Bolts	56._____	_____
57. Cutting edge, Curb Runner, Bolts	57._____	_____
58. D-Block Assembly	58._____	_____
59. Wing Marker	59._____	_____
Exterior: Right Side of Truck		
60. Front Tire (Condition, PSI, Spun, Lug Torque (230 spoke, 450 bud)	60._____	_____
61. Hub Oil Level (90w mineral oil)	61._____	_____
62. Ladder, Cab Steps and Grab Bar	62._____	_____
63. Duals (Condition, PSI, Spun, Lug Torque (230 spoke, 450 bud)	63._____	_____
64. Hopper Tie Downs, Flaps	64._____	_____
65. Hopper Grates	65._____	_____
66. Right Front Leaf Spring	66._____	_____
67. Exhaust System	67._____	_____
68. Under the Hood Tool Box (Fitted Tire Chains & Adjusters)	68._____	_____
Exterior: Rear of Truck		
69. Gate Setting	69._____	_____
70. Hopper Chain Condition	70._____	_____
71. Mud Flaps	71._____	_____
72. Spinner Chute, Deflectors, Dickey John Sensor	72._____	_____
73. Gate Crank Operable	73._____	_____
74. Left & Right Side Rear Leaf Springs	74._____	_____
75. Hydraulic Hoses	75._____	_____
76. Hopper Gear Box Oil Level (90x140 gear oil)	76._____	_____
77. Grease Hopper	77._____	_____
78. Liquid Saddle Tanks (Check for Operation & Leaks)	78._____	_____
79. Hoses from Saddle Tanks	79._____	_____
80. Conveyor Chain Gear Box Vent	80._____	_____

REMARKS:

_____ _____
_____ _____
_____ _____
_____ _____

APPENDIX C

APPLICATION RATES

FACTORS THAT AFFECT APPLICATION RATE DETERMINATION

TRAFFIC:

AADT – Higher traffic volumes result in mixing action along with heat from friction. Higher volumes are also an indication of more important roads.

Rush Hour – This affects timing and maneuverability as treatments are applied ahead of the rush. In extreme cases, it may be necessary to avoid a road because trucks will be trapped and non-productive. Rush hours can also create a directional situation where good mixing action takes place in one direction and almost none in the other.

Day of the Week – Different days, especially the weekend create different traffic patterns and volumes and the application may need to be changed to adjust for this.

Corridors – This is an evolving issue from Transformation, but has always influenced level of response. Certain roads are key to the function of the system and if they are not open the rest of the system fails regardless of the conditions on the feeder roads.

ROAD CONDITIONS:

Geometrics – Steep grades, sharp curves, bridge decks, etc. all influence our application rates. Some of these situations determine the application rate for a whole beat, and others require the driver to make adjustments during his run.

Cold Spots – Areas at higher elevations or shaded most of the day create cold spots which normally require more material than adjacent sections of the beat.

Length of Beat – This affects cycle time. The longer the time between plowings the more material is needed to prevent bonding. Narrowing of the spread pattern should accompany the increased application rate in this circumstance.

Plow Speed – While ideal plow speed is around 30 mph, it does vary considerably due to traffic adjacent buildings, pedestrians, high speed roadways, etc. This can create different cycle times between beats of the same length, or even the same beat at different times of the day.

Multiple Lanes – While in some cases a beat consists a uniform number of lanes so that the assigned trucks can plow in echelon in one pass. However in most cases the number of lanes varies and trucks have to double back or trucks from other beats have to be assigned to help. This results in increased cycle time.

Pavement Surface –Pavement treatments like Nova Chip and some Superpave mixes have an open graded structure which draws the brine away from the surface. More chemicals may need to be applied to prevent bonding.

WEATHER:

Time of Season –Usually, chemicals are required in January than March because of colder pavement temperatures and continued cold weather is likely.

Sunlight – The amount and angle of sunlight influences pavement temperatures and the resulting melting action of ice control chemicals.

Type of snow or ice – The wetter the precipitation the more chemical dilution occurs which requires more chemicals to keep the freezing point reduced.

Intensity of the precipitation – The harder the snowfall the more chemical will be needed to prevent bonding before the next treatment.

Pavement Temperature – While changes in air temperature are useful to watch, the pavement temperature is what really matters. When deciding on application rates the expected trend in the pavement temperature is important to be taken into account.

Note: The tables for application rates attempt to take into account the last three items.

GLOSSARY OF TERMS

Black Ice. Popular term for a very thin coating of clear, bubble free, homogenous ice which forms on a pavement with temperature at or slightly above 32° F when the temperature of the air in contact with the ground is below the freeze-point of water and small super cooled water droplets deposit on the surface and coalesce (flow together) before freezing. This often occurs when pavement temperature is 32° F or below and is at or below Dew Point.

Chemical Spread Rate. Also known as chemical application rate. For solid applications it is simply the weight of the chemical applied per lane mile. For liquid applications it is in gallons per lane mile when applied straight and gallons per ton when used to pre-wet solid chemicals.

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. 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). Most often occurs when pavement temperature is 32° F or below and is at or below Dew Point.

Light Snow. Snow falling at the rate of less than ½ inch per hour: visibility is not affected adversely.

Liquid Chemical. A chemical solution; with a specified percentage of chemical that is applied at the rate of gallons per lane when applied straight and gallons per ton when used to pre-wet solid chemicals.

Moderate or Heavy Snow. Snow falling a rate of ½ inch per hour or greater; visibility may be reduced.

Sleet. A mixture of rain and snow which has been partially melted by falling through the atmosphere with a temperature slightly above freezing.

Slush. Accumulation of snow which 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.

BLACK ICE

Surface Temp. Range (^{o} F)	Surface Condition	Initial Maintenance Action	Dry Rock Salt Lbs./lm.	Pre-Wetted Rock Salt Lbs./lm	Follow Up Action	Follow Up Rock Salt Lbs./lm	Follow Up Pre- Wetted Rock Salt Lbs./lm	Comments
Above 32	Dry or Damp	Apply pre-wetted rock salt or direct liquids to prevent formation.		115	None, see comments.			Monitor pavement temperature closely; begin treatment if pavement temperature starts to fall toward 32 and it is at or below the dew point.
23 to 32	Frost or Black Ice	Apply pre-wetted rock salt or direct liquid; use dry salt if pre-wetted not available.	275	225	Re-apply pre-wetted rock salt as needed.	115	90	1) Monitor pavement temperatures closely; if pavement becomes wet or if thin ice forms re-apply chemicals. 2) Do not apply direct liquids on ice so thick that the pavement cannot be seen. 3) Heavier follow up application(s) may be necessary.
15 to 23	Frost or Black Ice	Apply pre-wetted rock salt; use dry rock salt if pre-wetted not available.	360	275	Re-apply pre-wetted or dry rock salt as needed	115	90	1) Monitor pavement temperature closely; if pavement becomes wet or if thin ice forms re-apply chemicals. 2) Do not apply direct liquids on ice so thick that the pavement can not be seen. 3) Heavier follow up applications(s) may be necessary.
Below 15	Frost or Black Ice	Apply abrasives			Apply abrasives			1) Refer to Snow and Ice Guidelines Section 5.4406, paragraph B. for abrasive application rates.

Notes: 1) Black ice or frost is normally a spot condition – these application rates would be applied to areas susceptible to the formation of black ice or areas where black ice has developed. Watch for freezing surface temperatures below dew point with sources of vapor, clear night skies and light winds. 2) Refer to direct liquid chemical application guide lines (Appendix C Page C – 10) if anti-icing liquids are used.

FREEZING RAIN

Surface Temp. Range (^{o} F)	Surface Condition	Initial Maintenance Action	Dry Rock Salt Lbs./lm.	Pre-Wetted Rock Salt Lbs./lm	Follow Up Action	Follow Up Rock Salt Lbs./lm	Follow Up Pre- Wetted Rock Salt Lbs./lm	Comments
Above 32	Wet or Slushy	Apply pre-wetted or dry rock salt, plow if plowable.	115	90	Monitor precipitation and temperature.			1) Monitor pavement closely and anticipate drops toward 32^{o} F and below. 2) Adjust application rates as surface conditions and precipitation intensities change.
Above 32, but dropping to 32 or below soon	Wet or Slushy	Apply pre-wetted or dry rock salt, plow if plowable.	180	115	Re-apply pre-wetted or dry rock salt as needed.	180	115	1) Monitor pavement temperatures and precipitation closely. 2) Treat icy patches and colder areas with higher applications. 3) Increase applications if precipitation intensity increase or surface shows signs of icing.
23 to 32	Wet or Slushy	Apply pre-wetted or dry rock salt, plow if plowable.	275	225	Re-apply pre-wetted or dry rock salt as needed.	275	225	1) Monitor pavement temperatures and precipitation closely and adjust application rates as surface conditions and precipitation intensities change. 2) Treat icy patches and colder areas with higher applications. 3) Increase applications if precipitation intensity increase or surface shows signs of icing.
23 to 32	Icy	Apply pre-wetted or dry rock salt.	360	320	Re-apply pre-wetted or dry rock salt as needed.	360	320	1) Use Application Rate for "wet and slushy" when icing condition is removed. 2) Increase application rate if precipitation intensity increases or if pavement shows signs of re-freezing.
15 to 23	Wet or Slushy	Apply pre-wetted or dry rock salt, plow if plowable.	360	275	Re-apply pre-wetted or dry rock salt as needed.	360	275	1) Monitor pavement temperatures and precipitation closely and adjust application rates as surface conditions and precipitation intensities change. 2) Treat icy patches and colder areas with higher applications. 3) Increase applications if precipitation intensity increase or surface shows signs of icing.
15 to 23	Icy	Apply pre-wetted or dry rock salt.	450	360	Re-apply pre-wetted or dry rock salt as needed.	450	360	1) Use Application Rate for "wet and slushy" when icing condition is removed. 2) Increase application rate if precipitation intensity increases or if pavement shows signs of re-freezing.
Below 15	Dry, wet or icy	Apply abrasives			Re-apply abrasives			Refer to Snow and Ice Guidelines Section 5.440 (B) for application rates.

Notes: 1) Freezing Rain requires a timely and aggressive response to prevent ice formation; application rates should be increased if not effective or cycle times are increased due to difficult driving.

SLEET

Surface Temp. Range (^{o} F)	Surface Condition	Initial Maintenance Action	Dry Rock Salt Lbs./lm.	Pre-Wetted Rock Salt Lbs./lm	Follow Up Action	Follow Up Rock Salt Lbs./lm	Follow Up Pre- Wetted Rock Salt Lbs./lm	Comments
Above 32	Dry	Patrol and spot treat as needed. See comments.			Patrol and spot treat as needed. See comments.			1) Monitor pavement temperatures closely and anticipate drops toward 32 F and below. 2) Treat icy patches with pre-wetted rock salt at 115 lbs./lm.
Above 32	Snow, slush, or wet.	Apply pre-wetted or dry rock salt, plow if plowable.	115	90	Re-apply pre-wetted or dry rock salt as needed.	115	90	1) Monitor pavement temperatures closely and anticipate drops toward 32F. 2) Treat icy patches and colder areas with higher applications. 3) Increase rates if precipitation intensity increases.
Above 32, but dropping to 32 or below soon.	Snow, slush, or wet.	Apply pre-wetted or dry rock salt, plow if plowable.	180	115	Re-apply pre-wetted or dry rock salt as needed.	180	115	1) Monitor pavement temperatures and precipitation closely. 2) Treat icy patches and colder areas with higher application rates. 3) Increase application rates if precipitation intensity increases.
23 to 32	Snow, slush, or wet.	Apply pre-wetted or dry rock salt, plow if plowable.	225	180	Re-apply pre-wetted or dry rock salt as needed.	225	180	1) Monitor pavement temperatures and precipitation closely. 2) Treat icy patches and colder areas with higher application rates. 3) Increase application rates if precipitation intensity increases.
15 to 23	Snow, slush, or wet.	Apply pre-wetted or dry rock salt, plow if plowable.	275	225	Re-apply pre-wetted or dry rock salt as needed.	275	225	1) Monitor pavement temperatures and precipitation closely. 2) Treat icy patches and colder areas with higher application rates. 3) Increase application rates if precipitation intensity increases.
Below 15	Any condition.	Apply abrasives.			Re-apply abrasives.			1) Refer to Snow and Ice Guidelines Section 5.4406 (B) for abrasive application rates.

Notes: 1) Sleet that creates accumulating ice will require more aggressive treatment.

LIGHT SNOW
(Less than ½"/hour; visibility > ½ mile)

Surface Temp. Range (^{o} F)	Surface Condition	Initial Maintenance Action	Dry Rock Salt Lbs./lm.	Pre-Wetted Rock Salt Lbs./lm	Follow Up Action	Follow Up Rock Salt Lbs./lm	Follow Up Pre- Wetted Rock Salt Lbs./lm	Comments
Above 32	Wet, slush or light snow covered.	Patrol and spot treat as needed. See comments.			Patrol and spot treat as needed. See comments.			1) Monitor pavement temperature for drops toward 32 F. 2) Blast isolated icy patches with salt, treat slushy areas beginning to freeze with 180 dry/160 pre-wet, lbs./lm and plow as needed
Above 32, but dropping to 32 or below soon.	Dry	Apply pre-wetted rock salt or direct liquids. Patrol and spot treat as needed. See comments.		160	Patrol and spot treat as needed. See comments.			1) Monitor pavement temperature and precipitation and select appropriate follow up as conditions change.
Above 32, but dropping to 32 or below soon.	Wet, slush, or light snow covered.	Apply pre-wetted or dry rock salt, plow as needed.	180	160	Plow and re-apply pre-wetted or dry rock salt as needed.	115	100	1) Application will need to be more frequent at lower temperature and higher snowfall rates. 2) Adjust application rates as surface conditions and precipitation intensities change.
23 to 32	Dry	Apply pre-wetted rock salt or direct liquids.		160	See comments.			1) Monitor pavement temperature and precipitation and use select appropriate follow up as conditions change.
23 to 32	Wet, slush or light snow covered.	Apply pre-wetted or dry rock salt, plow as needed.	200	160	Plow and re-apply pre-wetted or dry rock salt as needed.	115	100	1) Application will need to be more frequent at lower temperature and higher snowfall rates. 2) Adjust application rates as surface conditions and precipitation intensities change.
15 to 23	Wet, slush or light snow covered.	Apply pre-wetted rock salt, plow as needed.	250	200	Plow and re-apply pre-wetted rock salt as needed.	180	160	1) If sufficient moisture is present, dry rock salt can be applied. Dry pavement at these temperatures is better left untreated if snow does not track to surface.
Below 15	Dry or light snow covered. Wet and Snow/ice/slush	Plow as needed. If previous salt applications made, plow and apply pre-wetted rock salt as needed.		200	Plow as needed. If previous salt applications made, plow and re-apply pre-wetted rock salt as needed.		160	1) Abrasives can be applied to enhance traction, a heavy salt mix will create glazing. Refer to Snow & Ice Guidelines Section 5.4406 (B) for abrasive application rates. Apply rock salt in anticipation of rising temperatures. 2) If salt had been applied prior, continue with pre-wet salt as needed.

Notes: 1) Rush Period Traffic on high volume highways may require more aggressive initial treatments. 2) Use weather information to anticipate changes in storm intensity, precipitation type, and surface temperatures; Use appropriate guideline for heavier intensity or precipitation type change. 3) Rates may need to be increased if cycle times are longer than normal. 4) In the event of hard pack or icing development, adjust application rates as needed. 5) For pre-storm anti-icing operations, refer to direct liquid chemical application guides lines. Consider use of follow-up application rates for initial maintenance action if pre-storm liquid anti-icing is effective.

April, 2006 (Revised November 2014)
Supersedes January 2012 revision

MODERATE OR HEAVY SNOW

(Moderate: ½ ”/– 1”/hour; visibility ¼ to ½ mile) (Heavy: More than 1”/hour; visibility < ¼ mile)

Surface Temp. Range (^{o} F)	Surface Condition	Initial Maintenance Action	Dry Rock Salt Lbs./lm.	Pre-Wetted Rock Salt Lbs./lm	Follow Up Action	Follow Up Rock Salt Lbs./lm	Follow Up Pre- Wetted Rock Salt Lbs./lm	Comments
Above 32	Wet, slush or light snow covered.	Patrol and spot treat as needed. See comments.			Patrol and spot treat as needed. See comments.			1) Monitor pavement temperature for drops toward 32 F. 2) Blast isolated icy patches with salt, treat slushy areas beginning to freeze with 180 dry/160 pre-wet, lbs./lm and plow as needed.
Above 32, but dropping to 32 or below soon.	Dry	Apply pre-wetted rock salt or direct liquids. Patrol and spot treat as needed. See comments.		160	Patrol and spot treat as needed. See comments.			1) Monitor pavement temperature and precipitation and select appropriate follow up as conditions change.
Above 32, but dropping to 32 or below soon.	Wet, slush, or light snow covered.	Apply pre-wetted or dry rock salt, plow as needed.	180	160	Plow and re-apply pre-wetted or dry rock salt as needed. Slushy Conditions	180 115	160 100	1) If normal cycle times can not be maintained, the application rates can be increased to 220 dry/180 pre-wet, lbs./lm to accommodate longer cycles.
23 to 32	Dry	Apply pre-wetted rock salt or direct liquids.		160	See comments.			1) Monitor pavement temperature and precipitation and use select appropriate follow up as conditions change.
23 to 32	Wet, slush or light snow covered.	Apply pre-wetted or dry rock salt, plow as needed.	200	160	Plow and re-apply pre-wetted or dry rock salt as needed. Slushy Conditions	200 115	160 100	1) If normal cycle times can not be maintained, the application rates can be increased to 250dry/200 pre-wet, lbs./lm to accommodate longer cycles. 2) See notes below.
15 to 23	Wet, slush or light snow covered.	Apply pre-wetted rock salt, plow as needed.	250	200	Plow and re-apply pre-wetted rock salt as needed. Slushy Conditions	250 200	200 100	1) If normal cycle times can not be maintained, the application rates can be increased to 325 dry/250 pre-wet, lbs./lm to accommodate longer cycles. 2) See notes below.
Below 15	Dry or light snow covered. Wet and Snow/ice/slush	Plow as needed. If previous salt applications made, plow and apply pre-wetted rock salt as needed.		200	Plow as needed. If previous salt applications made, plow and re-apply pre-wetted rock salt as needed.		160	1) Abrasives can be applied to enhance traction, a heavy salt mix will create glazing. Refer to Snow & Ice Guidelines Section 5.4406 (B) for abrasive application rates. Apply rock salt in anticipation of rising temperatures. 2) If salt had been applied prior, continue with pre-wet salt as needed.

Notes: 1) Rush Period Traffic on high volume highways may require more aggressive initial treatments. 2) Use weather information to anticipate changes in storm intensity, precipitation type, and surface temperatures; Use appropriate guideline for heavier intensity or precipitation type change. 3) Rates may need to be increased if cycle times are longer than normal. 4) In the event of hard pack or icing development, adjust application rates as needed. 5) For pre-storm anti-icing operations, refer to direct liquid chemical application guides lines. Consider use of follow-up application rates for initial maintenance action if pre-storm liquid anti-icing is effective.

ANTI-ICING WITH STRAIGHT LIQUID CHEMICALS

The strategy of anti-icing is to be proactive in the application of chemicals to prevent the formation or development of bonded snow and ice to the pavement surface. This tactic is used to "buy time" prior to the onset of a snow and ice event or anticipated black ice conditions. When the event actually begins, conventional reactive strategies are then used.

This strategy can be particularly useful on A1 type highways where conventional methods may be slowed due to high traffic volumes. These methods are also useful for unique trouble areas such as bridge decks, high elevations, and shaded areas that freeze quicker than adjoining segments.

Anti-icing can be done by applying conventional solid and pre-wetted solids on low speed, low volume roads. This tactic is prone to wasting material, particularly if the pavement surface is dry. High volumes and speeds will scatter most of the material off of the travel lanes. Higher treatment effectiveness can be achieved by placing the material on the high portion of the traffic lane where it is not subject to as much traffic. The preferred material for anti-icing is the use of salt brine or liquid chemicals such as magnesium chloride sprayed directly on the pavement surface using a tank and spray bar system. Various slide in tank and spray bar systems are now available.

Liquid Chemicals:

Liquid ice control chemicals are made up of solid ice control chemicals in a water solution. After application, the water evaporates and a residual dry chemical is left on the pavement surface. This material is not prone to scattering or dispersal from traffic conditions.

Salt brine is most effective at a 23% solution. It can be produced in house by agitating solid NACL in water. It is also a byproduct of the oil and gas industry and can be acquired in certain geographic areas at little or no cost.

Liquid Magnesium Chloride, Liquid Calcium Chloride, Potassium Acetate, Calcium Magnesium Acetate, and a variety of proprietary formulas that contain anti-corrosion inhibitors and agricultural byproducts are also available. Although generally higher in cost than salt brine, they can be more effective at lower temperatures.

Application Criteria:

Straight liquid chemical applications can be made up to 3 days prior to the onset of a winter weather event if the chemical is allowed to dry on the pavement surface. Rain events and particularly high traffic volumes will lesson the anti-icing effects. Table A gives a general range of application rates. The rates to achieve effective results can vary significantly with the type of

liquid chemical used and pavement temperatures. Too little material will not produce desired results. On very rare occasions too much material (liquid chemicals other than salt brine) can result in hazardous slippery conditions before the material has fully dried. The use of pencil or streamer nozzles to distribute these liquid chemicals onto the pavement will further reduce the potential for any unintended slipperiness. It is recommended that new users start at the lower end of the range and gradually increase application rates until desired results are achieved. It is also very critical that liquid spray units are calibrated at the beginning of each snow and ice season. This can be accomplished by collecting liquid at the spray bar over a pre-measured distance. Because results are very sensitive to application rates, calibration is critical.

Liquid chemicals should only be applied as an anti-icing strategy when the pavement temperatures are 20°F or higher. Application of salt brine at lower temperatures would require excessive application rates and may be prone to rapid refreeze. Liquid chemicals such as magnesium chloride and other proprietary products may be used at lower temperatures, but again, application rates may negate any cost benefit. Conversely, liquid applications should not be made if pavement temperatures are much above freezing. Above 38°F and at high humidity, liquid chemicals will not properly dry on the surface and can result in hazardous slippery conditions.

De-icing:

Straight liquid chemicals may be applied as a de-icing strategy during low moisture, light snowfall at pavement temperatures above 20°F. Cycle times should be minimized as dilution of straight liquids occurs much quicker than solid chemical applications. At temperatures near freezing, it can be very effective at melting thin ice in the absence of precipitation.

Liquid chemicals are more sensitive to temperature and dilution than solid abrasives. If used as a de-icing strategy, more caution is required to avoid refreeze without the friction enhancement characteristics of a solid material.

Table A

SUGGESTED APPLICATION RATES FOR STRAIGHT LIQUID ANTI-ICING			
Temperature °F	*Application Rate gals/lm		
	23% Salt Brine	27% Mag Chloride	32% Calcium Chloride
32°F	30	28	33
20°F	40	30	36

** Application rates as high as 60 gal/lm have been successfully used in salt brine straight liquid applications. It is strongly recommended however, to start with the application rates as illustrated by this table.*

APPENDIX D

ABRASIVES – SNOW AND ICE CONTROL SPECIFICATIONS

NEW YORK STATE DEPARTMENT OF TRANSPORTATION
GROUP SPECIFICATION
ABRASIVES – SNOW & ICE CONTROL (Delivered to Stockpile)

BIDDERS ARE REQUESTED TO RETAIN THIS SPECIFICATION FOR FUTURE REFERENCE

DIRECT INQUIRIES REGARDING THIS SPECIFICATION TO: Mike Lashment, Transportation Operations Division, (518) 457 - 5796

SCOPE

This specification covers the material requirements and basis of acceptance for abrasives used to treat snow and ice on pavements.

MATERIAL REQUIREMENTS

The material for abrasives shall be either natural sand, manufactured sand, iron ore tailings, slag or lightweight aggregate conforming to the requirements of these specifications. All abrasives shall consist of hard, durable particles that are free from injurious amounts of clay, loam or other undesirable material or hazardous substances.

Abrasive materials meeting the requirements of these specifications shall be accepted unless the Director of Transportation Operations Division determines, from test results, or service records that (1) the material contains sufficient unsound or undesirable material to be harmful, (2) the particles degrade due to weathering in storage or while in service such that the abrasive material is ineffective.

CERTIFICATION AND GRADATION ANALYSIS

Bidders are required to submit a current gradation analysis (sample taken within 6 months of bidding) for each proposed source of supply on their bids. This requirement is waived if the proposed source is named on the most current listing of the NYSDOT approved list of sources of fine and coarse aggregates for Portland Cement Concrete Sand published by the Materials Bureau of the New York State Department of Transportation. Attachment 1 of the proposal is to be used for recording the gradation test results or indicating the NYSDOT Approved Source Number. The gradation test, if required, may be performed by the producer, bidder or an independent testing laboratory. On Attachment 1, the bidder is further required to certify that the gradation analysis represents the material to be supplied and that sufficient acceptable material is available to meet the requirements of the item(s) bid. Bids shall be rejected if the certified gradation is not in conformance with the *"Special Gradation"* for the locations bid. If the certification sheet is not properly executed (completely filled out and signed), the bid shall be declared incomplete.

INCOMPLETE BIDS

Bidders will have ten (10) calendar days from issuance of notice by the Department to provide missing gradation or other information. Failure to provide the missing information within the specified time period shall be cause for rejection of the bid.

GRADATION

The gradation requirements for the various items in this proposal are listed on the gradation sheet of this specification. NOTE: The Specification Gradation Sheet is to be used for bidding purposes. The Rejection Gradation Sheet will only be used at the time of delivery to determine the acceptability of the load.

GRADATION ACCEPTANCE

Gradation acceptance of abrasive material shall be based on the condition that the material meets the specification requirements. Acceptance shall be determined at the final point of sampling. Depending on the production operation and uniformity of delivered material, the final point of acceptance sampling could be the producer's stockpile, production operation, pit or a lot of delivered material. Depending on the production operation, the Department may require that exclusive stockpiles be built, tested and approved prior to delivery. If the material deviates from the SPECIFICATION GRADATION requirements listed on the attached gradation sheet, an adjusted price may be paid for the material. The adjusted price shall be based on the average values of at least two samples representing a pit location, lot, stockpile or process.

SAMPLING

Sampling will be performed by Department personnel or their representatives and will depend on the operation of the successful low bidder. Where stockpiles exist, the material will be sampled in the stockpiles prior to delivery. Where material is being processed shortly in advance of or at the time of delivery, the process will be sampled. Where the material is unprocessed, specific working areas of the source will be sampled prior to delivery. All delivered materials are subject to random and/or specific sampling if a problem is suspected. Sampling methods, locations and point of final acceptance will be determined by the Department of Transportation.

LOT

A lot shall be the total of one eight hour day's delivery during normal Residency working hours.

TESTING METHOD

Gradation testing shall be performed on samples by sieving in conformance with NYSDOT Materials Bureau Test Methods 703-1P and 703-2P. Moisture content shall be determined by AASHTO Test Method T-255.

– USE FOR BID ELIGIBILITY –

Specific Gradation Sheet*

		PERCENT PASSING
GRADATION	SIEVE SIZE	SPECIFICATION GRADATION
A	1/2"	100
	3/8"	100
	#4	80-100
	#50	0-18
	#200	0-3
B	1/2"	100
	3/8"	100
	#4	80-100
	#50	0-25
	#200	0-5
C	1/2"	100
	3/8"	100
	#4	80-100
	#50	0-35
	$200	0-5

*NOTE: The above table is to be for determining bid eligibility. To be acceptable, the Gradation Analysis must show that the proposed source meets the specifications.

– DO NOT USE FOR ELIGIBILITY –

Rejection Gradation Sheet**

GRADATION	SIEVE SIZE	PERCENT PASSING REJECTION GRADATION	PENALTY FACTOR
A	1/2"	100	-
	3/8"	95-100	1
	#4	70-100	1
	#50	0-22	2
	#200	0-5	5
B	1/2"	100	-
	3/8"	95-100	1
	#4	70-100	1
	#50	0-30	2
	#200	0-8	5
C	1/2"	100	-
	3/8"	95-100	1
	#4	70-100	1
	#50	0-40	2
	#200	0-8	5

**NOTE: The above table is *NOT* to be used to determine bid eligibility (see Specification Gradation sheet for that use). Rejection Gradation is used to determine the acceptability of delivered material and calculate reduced payment, if necessary.

MOISTURE CONTENT

Abrasives when delivered shall have a maximum moisture content of 7.0% as determined by AASHTO Test Method T-255 (moisture content of fine and coarse aggregate).

METHOD OF DELIVERY

The bidding unit for abrasives is U.S. Tons (weight). The method for accounting for delivery involves collecting weight tickets from scales that have been certified by the appropriate Municipal jurisdiction and are signed by certified weigh masters.

ESTIMATE OF QUANTITIES

Quantities indicated in the Bid Proposal represent the Resident Engineer's best estimate for a normal winter. The Department reserves the right, afterward, to order 20% more or less than the quantities called for in the contract. Notwithstanding the foregoing, the Department may purchase greater or lesser percentages of the contract quantities with the Contractor's concurrence.

DELIVERY SCHEDULES

Delivery schedules shall be approved by the Resident Engineer. The delivery of material shall not be less than 200 tons and not more than 1,000 tons per day. Deliveries will be accepted between the hours of 7:30 A.M. and 3:00 P.M. unless exceptions are specifically granted by the Resident Engineer.

REJECTED MATERIALS

When materials are rejected, they must be removed by the Contractor within ten (10) days of notification of rejection. Rejected items not removed by the Contractor within the said ten (10) days shall be regarded as abandoned by the Contractor. The Department then shall have the right to dispose of said abandoned material as its own property. The Contractor shall promptly reimburse the Department for any and all costs incurred in effecting such disposal.

WEIGHT/VOLUME CONVERSION

Locations (delivery sites) where volumetric delivery is acceptable shall be specifically identified in the Bid Proposal. These are typically areas where certified scales and weigh masters are not available within a reasonable distance of the delivery site. In those cases, the weight/volume conversion ratio shall be determined by the Resident Engineer with assistance from the Regional Materials Group as necessary.

There are two acceptable methods for establishing weight/volume conversion;

Method 1

Each delivery truck shall have its "level struck" (all material in the dump body being level with the top of the sides of the dump body); volume determined by the Resident Engineer. This will be the payment volume for each load delivered. A representative of the Resident Engineer shall record each load delivered and certify that the truck contained at least the payment (level struck) volume.

The test method for determining unit weight for the purpose of determining weight/volume conversion is:

Equipment Required

1 - 1/4 cu. ft. container (typically used for measuring the air content 9of plastic concrete).

1 - 20 oz. Rubber mallet.

1 - straight edge suitable for striking the abrasive level with the top of the container.

1 - smooth working surface.

1 - scale having a minimum 40 lb. capacity and accuracy of ± 0.3 lbs.

1 - flat shovel.

Sampling of Abrasives

A representative sample of about ½ cu. ft. (4 gal.) of abrasives shall be obtained from a prepared stockpile according to procedures found in Appendix "A" of Materials Method 9.1 "Plant Inspection of Portland Cement Concrete" prior to delivery.

Testing the Sample for Unit Weight

1.The sample shall be air or oven dried until it is visibly dry.

2.Thoroughly mix the "room temperature" sample into a pile on the smooth surface with a flat shovel and "quarter" the pile.

3.Remove about 1/16 cu. ft. (about two quarts) of material from one of the quarters. Place it in the 1/4 cu. ft. container and roughly level it off.

4.Strike the container firmly three times about midway on the side at one point. Repeat the striking procedure at three more points about 90 degrees apart on the container.

5.Repeat steps 3 & 4 three more times with material from each of the remaining three "quarters" of the same pile. Be sure that 1/4 cu. ft. container is "overfull" after material from the fourth quarter of the sample pile is placed in it.

6.Screed the material level with the top of the container.

7.Weigh the "level full" container on the scales and record the weight in pounds.

8.Subtract the weight in pounds of the empty 1/4 cu. ft. container from the weight recorded from step #7 above. This is the weight, in pounds, of 1/4 cu. ft. of the abrasive material. To obtain the weight, in tons, of 1 cubic yard of the abrasive material, multiply the weight of the 1/4 cu. ft. by 0.054.

Method 2

Each delivery truck shall have its "level struck" weight of abrasives determined by a weigh master on a certified weight scale. This is obtained by subtracting the empty weight of the truck from the certified loaded "level struck" weight. As in Method 1, each load delivered shall be recorded by a representative of the Resident Engineer and be certified that the truck contained at least the same volume of the "level struck" weight previously recorded.

PRICES

Prices shall be FOB destination, including delivery to the locations specified.

PAYMENT OF INTEREST

The payment of interest on payments due and owed by a State Agency will be made in accordance with the criteria established by Chapter 153, Laws of 1984 (Article 11A of the New York State Finance Law) and the Comptroller's Bulletin No. A-91 (Prompt Payment).

PAYMENT

Payment will be made upon satisfactory delivery and acceptance of material. Invoices are to be sent to the New York State Department of Transportation at the address indicated on the Purchase Order issued by the Resident Engineer.

DELIVERY

Bidders must guarantee delivery within 14 calendar days or less after receipt of an order (written or verbal) from the Department. Orders shall not call for deliveries of less than 200 tons or more than 1,000 tons per day.

SUSPECTED PROBLEMS DURING DELIVERY

If the Resident Engineer, or an authorized representative of same, as a result of visual inspection, suspects the abrasives being delivered are not within specification limits, they shall immediately notify the supplier of the nature of the suspected problem(s) verbally and in writing. At that point, all deliveries from that supplier will cease until the Department has had reasonable opportunity to sample and test the suspect material (3 working days, not including the date of written notification). If the supplier requests to continue delivering material after notification in writing, the Resident Engineer may approve that request in writing. However, the material delivered after notification must be kept separate from that which was delivered prior to notification. The action deemed necessary by the test results shall be applicable to the lot delivered the day of notification and any subsequent lots delivered during the three day testing and sampling period. This process shall be utilized at any time when delivery of out of specification material is suspected.

ADJUSTED BID PRICE AND REJECTION RELATIVE TO GRADATION

The bid price shall be adjusted for any delivered material outside the limits given under "Specification Gradation" and within the limited of the "Rejection Gradation". Any material that has one or more sizes that fall outside the "Rejection Gradation" limits shall be rejected and no payment will be made for that material.

Example of Bid Price Adjustment for Out-of-Gradation Material

Percent Passing

Sieve	Example Specification Gradation	Example Rejection Gradation	Example Penalty Factor
1/2"	100	100	-
3/8"	100	95-100	1
#4	80-100	70-100	1
#50	0-25	0-30	2
#200	0-5	0-8	5

Reduced price per ton = contract price times (1.0 - X)

The percent out of tolerance shall be to the nearest 1%. The sum of the individual sieve tolerance deviations (%) times the appropriate penalty factors divided by 100 shall be used as "X".

Example: Sand delivered was bid at $5.00 per ton and is satisfactory in passing the 3/8" and #4 sieve but has 30% passing the #50 sieve and 6% passing the #200 sieve. The reduced price is computed as follows:

X = (30% - 25%) X 2 + (6% - 5%) X 5 = 15% = 0.15

Reduced price per ton = $5.00 X (1.00 - .15) = $4.25

Rejection and Reduced Price for Excess Moisture Content

Excessive moisture content has a significant negative impact on mixing, stockpiling and storage operations. Abrasives delivered that have a moisture content in excess of 7.00% and less than 10% may be rejected or accepted at a reduced unit price at the discretion of the Resident Engineer. Abrasives that have moisture content of 10% or higher shall be rejected.

The reduced unit price for affected delivery lots shall be computed as follows:

Moisture Content, %	**Reduction in Unit Price, %**
7.01 - 8.00	10.0
8.01 – 9.00	20.0
9.01 – 9.99	30.0
10.00 or higher	Rejection Required

APPENDIX E

REFERENCE MATERIAL

April, 2006 (Revised January 2012)

REFERENCE MATERIAL

Ketcham, S., L.D. Minsk, R. R. Blackburn, E. J. Fleege, "Manual of Practice for Effective Anti-Icing Program: A Guide for Highway Winter Maintenance Personnel," Report No. FHWA-RD-95-202, Federal Highway Administration, Washington, D.C., June 1996.

Blackburn, R. R., K. M. Bauer, D. E. Amsler, Sr., S. E. Boselly, A. D. McElroy, "Guidelines For Snow and Ice Control Materials and Methods," NCHRP Report No. 6-13, National Cooperative Highway Research Program, Washington, D.C., May 2003.

Boselly, S. E., R. R. Blackburn, D. E. Amsler, Sr., "Guide For Snow and Ice Control", NCHRP Report No. 20-7, National Cooperative Highway Research Program, Washington, D.C., February 1998.

Keep, Dale, "Snow & Ice Control Chemicals: Theory & Practice," Washington State DOT

Nixon, W. A., A. D. Williams, "A Guide For Selecting Anti-Icing Chemicals Version 1.0", University of Iowa, Iowa City, IA, October 2001.

"Guide for Snow and Ice Control", American Association of State Highway and Transportation Officials, Washington, D.C., 1999.

Amsler, Sr., D. E., "Snow and Ice Control", Cornell Local Roads Program, Ithaca, N.Y., 2000.

Amsler, Sr., d. E., "Level of Service – Strategies and Tactics – Liquid Ice Control Chemicals", Cornell Local Roads Program, Ithaca, N.Y. September 2003

"Highway Design Manual – Chapter 5: Basic Design", New York State Department of Transportation, Albany, N.Y., August 2001

"Environmental Handbook for Transportation Operations", New York State Department of Transportation, Albany, N.Y., January 2002

"Municipal-State Agreements For Control of Snow and Ice on State Highways: Terms, Reimbursement Procedures and Documentation", New York State Department of Transportation, Albany, N.Y., December 1999.

"Equipment Rental Rate Schedule", New York State Department of Transportation, Albany, N.Y., January 2000.

"The Snow fighter's Handbook", Salt Institute, Alexandria, VA, 1999

"Salt Storage Handbook", Salt Institute, Alexandria, VA, 1997