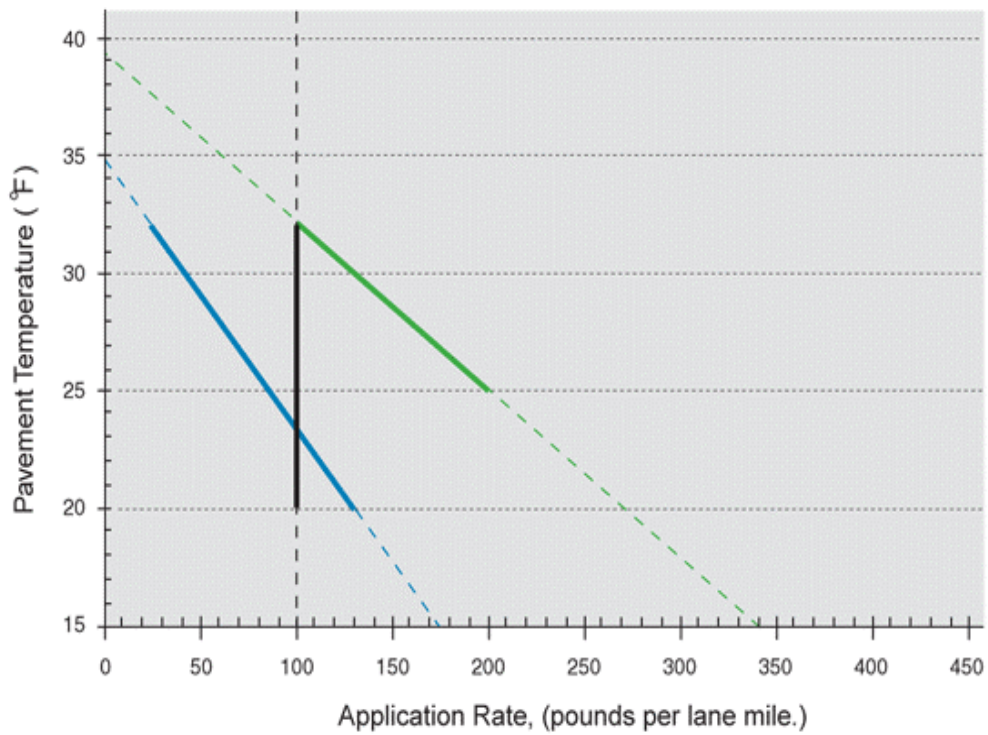


Chapter 6

Material Application Guidelines (Based on the FHWA Manual of Practice for an Effective Anti-icing Program)



Green line - liquid chemical applied in heavy snow storm **Blue line** - liquid chemical applied for frost or black ice
Black line - liquid chemical applied in light to moderate snow storm

(Dashed line is only a trend indication)

MATERIAL APPLICATION GUIDELINES

1. INTRODUCTON

The following material application guidelines are intended to complement WSDOT region and area application guidelines which better represent practices unique to their own geographical location. These guidelines may serve as a basis for such local guidelines, or be used in kind to support decision-making and best management practices of a systematic anti-icing program. Local application guidelines which have regional management concurrence should always take precedence.

The department is also committed to reducing corrosion and maximizing the performance characteristics of solid material. Towards that end, the statewide standard application for solid material will be to pre-wet solid material with a minimum of 10 gallons of corrosion inhibited liquid anti-icer. A higher concentration of liquid anti-icer in combination with solid material is both allowed and recommended as such applications have been shown to be extremely effective in a variety of road and weather conditions.

This guide is based upon the Federal Highway Administration's (FHWA) "Manual of Practice for an Effective anti-icing Program" and the "National Cooperative Highway Research Program" (NCHRP) 6-13. The Manual of Practice for an Effective anti-icing Program provides the results of four years of anti-icing field-testing conducted by 15 State highway agencies and supported by the Strategic Highway Research Program (SHRP) and the Federal Highway Administration (FHWA). This guide also uses information obtained from the National Cooperative Highway Research Program (NCHRP) 6-13. Both manuals provide application rates for Sodium Chloride (NaCl). This Guide has been prepared to show equivalent material application rates for Calcium Chloride (CaCl₂), Magnesium Chloride (MgCl₂), and Calcium Magnesium Acetate (CMA)

2. GUIDANCE FOR ANTI-ICING OPERATIONS

Guidance for anti-icing operations is presented in Tables 1 to 6 for six distinctive winter weather events. The six events are:

1. Light Snow Storm
2. Light Snow Storm with Period(s) of Moderate or Heavy Snow
3. Moderate or Heavy Snow Storm
4. Frost or Black Ice
5. Freezing Rain Storm
6. Sleet Storm

The tables suggest appropriate maintenance actions to take during either an initial or subsequent (follow-up) anti-icing operation for a given weather event. Each action is defined for a range of pavement temperatures and an associated air temperature trend. For some events, the operation is dependent not only on the pavement temperature and trend, but also upon the pavement surface or traffic condition at the time of the anti-icing action. Most of the maintenance actions involve chemical applications in a solid, liquid, or pre-wetted solid form. Application rates or "spread rates" are given for each chemical option to be used appropriately. These are suggested values and should be adjusted, if necessary, to achieve increased effectiveness or efficiency, for local conditions. Application rates in volumetric units (gal/lane-mi) are calculated from dry chemical rates. Comments and notes are given in each table where appropriate to further guide the maintenance field personnel in their anti-icing operations.

3. GLOSSARY OF TERMS

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

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 glaze or clear ice. Non-super cooled raindrops falling on a surface whose temperature is well below freezing will also result in glaze.

Frost: Also called hoarfrost. Ice crystals in the form of scales, needles, feathers or fans deposited on surfaces cooled by radiation or by other processes. The deposit 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).

Light Snow: Snow falling at the rate of less than 1/2 inch per hour; visibility is not affected adversely.

Liquid Chemical: A chemical solution; the volume of solution applied per lane mile is the chemical application rate used in this appendix.

Moderate or Heavy Snow: Snow falling at a rate of 1/2 inch per hour or greater; visibility is significantly reduced.

Sleet: A mixture of rain and snow, which has been partially melted by falling through an 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 its freely drained capacity. It will not support any weight when stepped or driven on but will “squish” until the base support is reached.

Pre-wetting: The practice of applying liquid chemical to dry material before it is placed on the pavement

Dry Chemical Spread Rate. For solid chemical applications, it is simply the weight of the chemical applied per lane mile. For liquid applications it is the amount of liquid chemical applied per lane mile.

Table 1. Weather event: LIGHT SNOW
Using a 32% concentration of Calcium Chloride

| PAVEMENT TEMPERATURE RANGE, AND TREND | INITIAL OPERATION | | | SUBSEQUENT OPERATIONS | | COMMENTS |
|---|---|--------------------|---|--|---|---|
| | Pavement surface at time of Initial operation | Maintenance Action | Chemical spread rate (gal/l _n -mi) Liquid CaCl ₂ | Maintenance Action | Chemical spread rate (gal/l _n -mi) Liquid CaCl ₂ | |
| Above 32°F, Steady or rising | Dry, wet, slush, or light snow cover | None, see comments | N/R | None, see comments | N/R | *Monitor pavement temperature closely *Treat icy patches if needed with chemical at 15-35 GPLM... plow if needed |
| 32°F, or below is imminent; | Dry | Apply liquid | 15-35 | Plow as needed; reapply liquid Chemical when needed | 15-35 | *Application rates will depend on dilution potential |
| ALSO 20 to 32°F, Remaining in range | Wet, slush, or light snow cover | | 20-40 | | 20-40 | |
| 15 to 20°F, Remaining in range | Dry, wet, slush, or light snow cover | | 30-65 | | 30-65 | |
| Below 15°F, Steady or falling | Dry or light snow cover | Plow as needed | N/R | Plow as needed | N/R | * It is not recommended that chemicals be applied in this temperature range * Abrasives can be applied to enhance traction |

CHEMICAL APPLICATIONS: These application rates are starting points. Local experience should refine these recommendations. Time chemical applications to *prevent* deteriorating conditions or development of packed and bonded snow. Monitor temperature and humidity to determine application timing.

PLOWING: Before applying any ice control chemical, the surface should be cleared of as much snow and ice as possible

CHEMICAL RATES: The recommended snow and ice control material application rates depend on atmospheric and pavement conditions at the time of treatment and on how these conditions are expected to change over the time period (window) between the current treatment and the next anticipated treatment.

SOLID DEICER: See Sodium Chloride for application recommendations.

Table 2. Weather event: LIGHT SNOW STORM WITH PERIOD (S) OF MODERATE OR HEAVY SNOW

Using a 32% concentration of **Calcium Chloride**

| PAVEMENT TEMPERATURE RANGE, AND TREND | INITIAL OPERATION | | | SUBSEQUENT OPERATIONS | | COMMENTS N/R=Not Recommended |
|---------------------------------------|---|--------------------|----------------------------------|--|----------------------------------|--|
| | Pavement surface at time of Initial operation | Maintenance Action | Chemical spread rate (gal/ln-mi) | Maintenance Action | Chemical spread rate (gal/ln-mi) | |
| | | | Liquid CaCl ₂ | | Liquid CaCl ₂ | |
| Above 32°F, Steady or rising | Dry, wet, slush, or light snow cover | None, see comments | N/R | None, see comments | N/R | *Monitor pavement temperature closely *Treat icy patches if needed with chemical at 15-35 GPLM... plow if needed |
| 32°F, or below is imminent; | Dry | Apply liquid | 15-35 | Plow as needed; reapply liquid Chemical when needed | 15-35 | *Do not apply liquid chemical onto heavy snow accumulation or packed snow * Application rates will depend on dilution potential |
| ALSO 20 to 32°F, Remaining in range | Wet, slush, or light snow cover | | 20-40 | | 20-40 | |
| 15 to 20°F, Remaining in range | Dry, wet, slush, or light snow cover | | 30-70 | | 30-70 | |
| Below 15°F, Steady or falling | Dry or light snow cover | Plow as needed | N/R | Plow as needed | N/R | * It is not recommended that chemicals be applied in this temperature range * Abrasives can be applied to enhance traction |

CHEMICAL APPLICATIONS: These application rates are starting points. Local experience should refine these recommendations. Time chemical applications to *prevent* deteriorating conditions or development of packed and bonded snow. Monitor temperature and humidity to determine application timing.

PLOWING: Before applying any ice control chemical, the surface should be cleared of as much snow and ice as possible

CHEMICAL RATES: The recommended snow and ice control material application rates depend on atmospheric and pavement conditions at the time of treatment and on how these conditions are expected to change over the time period (window) between the current treatment and the next anticipated treatment.

SOLID DEICER: See Sodium Chloride for application recommendations.

Table 3. Weather event: MODERATE OR HEAVY SNOW STORM

Using a 32% concentration of **Calcium Chloride**

| PAVEMENT TEMPERATURE RANGE, AND TREND | INITIAL OPERATION | | | SUBSEQUENT OPERATIONS | | COMMENTS N/R=Not Recommended |
|---------------------------------------|---|-----------------------------|---|--|---|--|
| | Pavement surface at time of Initial operation | Maintenance Action | Chemical spread rate (gal/l _n -mi) | Maintenance Action | Chemical spread rate (gal/l _n -mi) | |
| | | | Liquid CaCl ₂ | | Liquid CaCl ₂ | |
| Above 32°F, Steady or rising | Dry, wet, slush, or light snow cover | None, see comments | N/R | None, see comments | N/R | *Monitor pavement temperature closely *Treat icy patches if needed with chemical at 15-35 GPLM plow if needed |
| 32°F, or below is imminent; | Dry | Apply pre-wet solid NaCl | N/R | Plow accumulation and reapply pre-wet solid chemical as needed | N/R | * If sufficient moisture is present, solid chemical without pre-wetting can be applied * Do not apply liquid chemical onto heavy snow accumulation or packed snow |
| ALSO 20 to 32°F, Remaining in range | Wet, slush, or light snow cover | | N/R | | N/R | |
| 15 to 20°F, Remaining in range | Dry, wet, slush, or light snow cover | | N/R | | N/R | |
| Below 15°F, Steady or falling | Dry or light snow cover | Plow accumulation as needed | N/R | Plow accumulation as needed | N/R | * It is not recommended that chemicals be applied in this temperature range * Abrasives can be applied to enhance traction |

CHEMICAL APPLICATIONS: These application rates are starting points. Local experience should refine these recommendations. Time chemical applications to *prevent* deteriorating conditions or development of packed and bonded snow. Monitor temperature and humidity to determine application timing.

PLOWING: Before applying any ice control chemical, the surface should be cleared of as much snow and ice as possible

CHEMICAL RATES: The recommended snow and ice control material application rates depend on atmospheric and pavement conditions at the time of treatment and on how these conditions are expected to change over the time period (window) between the current treatment and the next anticipated treatment.

SOLID DEICER: See Sodium Chloride for application recommendations.

Table 4. Weather event: FROST OR BLACK ICE
Using a 32% concentration of Calcium Chloride

| PAVEMENT TEMPERATURE RANGE, AND TREND | TRAFFIC CONDITION | INITIAL OPERATION | | SUBSEQUENT OPERATIONS | | COMMENTS |
|--|---|-----------------------|--|-----------------------------------|--|--|
| | | Maintenance Action | Chemical spread rate (gal/l _n -mi) Liquid CaCl₂ | Maintenance Action | Chemical spread rate (gal/l _n -mi) Liquid CaCl₂ | N/R=Not Recommended |
| 32°F, Steady or rising | Any level | None, see comments | N/R | None, see comments | N/R | *Monitor pavement temperature closely; begin treatment if temperature starts to fall to 32°F or below and is at or below dew point |
| 28 to 32°F, Remaining in range or falling 32°F or below, and equal to or below dew point | Traffic rate less than 100 vehicles per hour | Apply liquid chemical | 10-25 | Reapply liquid chemical as needed | 10-25 | * Application rates will depend on dilution potential |
| | Traffic rate greater than 100 vehicles per hour | | 20-35 | | 20-35 | |
| 15 to 28°F, Remaining in range, and equal to or below dew point | Any level | | 20-40 | | 25-40 | * Application rates will depend on dilution potential |
| Below 15°F, Steady or falling | Any level | Apply abrasives | N/R | Apply abrasives as needed | N/R | * It is not recommended that chemicals be applied in this temperature range * Abrasives can be applied to enhance traction |

CHEMICAL APPLICATIONS: These application rates are starting points. Local experience should refine these recommendations. Time chemical applications to *prevent* deteriorating conditions or development of packed and bonded snow. Monitor temperature and humidity to determine application timing.

PLOWING: Before applying any ice control chemical, the surface should be cleared of as much snow and ice as possible

CHEMICAL RATES: The recommended snow and ice control material application rates depend on atmospheric and pavement conditions at the time of treatment and on how these conditions are expected to change over the time period (window) between the current treatment and the next anticipated treatment.

Table 5. Weather event: FREEZING RAINSTORM

Using a 30% concentration of **Magnesium Chloride**

Using a 32% Calcium ***Chloride***

Using a 25% concentration of **CMA**

CHEMICAL APPLICATIONS: It is possible to use these chemicals during this event but is not recommended. However, these products can be used through a pre-wet system to increase solid / abrasive efficacy. The application rate for liquids alone would be cost prohibitive and the potential for dilution is high. It is recommended to use a solid chemical application or abrasives.

Using Solid **Sodium Chloride**

| PAVEMENT TEMPERATURE RANGE, AND TREND | INITIAL OPERATION | | SUBSEQUENT OPERATIONS | | COMMENTS |
|---------------------------------------|----------------------|---|----------------------------------|---|---|
| | Maintenance Action | Chemical spread rate (lb/ln-mi) NaCl | Maintenance Action | Chemical spread rate (lb/ln-mi) NaCl | |
| Above 32°F, Steady or rising | None, see comments | N/R | None, see comments | N/R | N/R=Not Recommended * Monitor pavement temperature closely *Treat icy patches if needed with pre-wetted solid chemical at 100--150 lb/lane-mi |
| 32°F, or below is imminent | Apply solid chemical | 100-200 | Reapply solid chemical as needed | 100-200 | *Monitor pavement temperature and precipitation closely * Application rates will depend on dilution potential |
| 20 to 32°F, Remaining in range | | 200-300 | | 200-300 | |
| 15 to 20°F, Remaining in range | | 250-400 | | 250-400 | |
| Below 15°F, Steady or falling | Apply abrasives | N/R | Apply abrasives as needed | N/R | * It is not recommended that chemicals be applied in this temperature range * Abrasives can be applied to enhance traction |

CHEMICAL APPLICATIONS: These application rates are starting points. Local experience should refine these recommendations. Time chemical applications to *prevent* deteriorating conditions or development of packed and bonded snow. Monitor temperature and humidity to determine application timing.

PLOWING: Before applying any ice control chemical, the surface should be cleared of as much snow and ice as possible

CHEMICAL RATES: The recommended snow and ice control material application rates depend on atmospheric and pavement conditions at the time of treatment and on how these conditions are expected to change over the time period (window) between the current treatment and the next anticipated treatment.

Table 6. Weather event: SLEET STORM

Using a 32% concentration of **Calcium Chloride**

| PAVEMENT TEMPERATURE RANGE, AND TREND | INITIAL OPERATION | SUBSEQUENT OPERATIONS | COMMENTS |
|---------------------------------------|-------------------|-----------------------|----------|
|---------------------------------------|-------------------|-----------------------|----------|

| | Maintenance Action | Liquid CaCl₂ | Maintenance Action | Liquid CaCl₂ | N/R=Not Recommended |
|--------------------------------|--------------------|--------------------------------|--|--------------------------------|-----------------------------|
| Above 32°F, Steady or rising | None, see comments | N/R | None, see comments | N/R | Go to Sodium Chloride Chart |
| 32°F, or below is imminent | Apply solid NaCl | N/R | Plow accumulation and reapply pre-wet solid chemical as needed | N/R | |
| 28 to 32°F, Remaining in range | | | | | |
| 15 to 28°F, Remaining in range | | | | | |
| Below 15°F, Steady or falling | Plow as needed | N/R | Plow as needed | N/R | |

CHEMICAL APPLICATIONS: These application rates are starting points. Local experience should refine these recommendations. Time chemical applications to *prevent* deteriorating conditions or development of packed and bonded snow. Monitor temperature and humidity to determine application timing.

PLOWING: Before applying any ice control chemical, the surface should be cleared of as much snow and ice as possible

CHEMICAL RATES: The recommended snow and ice control material application rates depend on atmospheric and pavement conditions at the time of treatment and on how these conditions are expected to change over the time period (window) between the current treatment and the next anticipated treatment.

Table 1. Weather event: LIGHT SNOW

Using a 30% concentration of Magnesium Chloride

| PAVEMENT TEMPERATURE RANGE, AND TREND | INITIAL OPERATION | | | SUBSEQUENT OPERATIONS | | COMMENTS N/R=Not Recommended |
|--|---|--------------------|----------------------------------|---|----------------------------------|---|
| | Pavement surface at time of Initial operation | Maintenance Action | Chemical spread rate (gal/ln-mi) | Maintenance Action | Chemical spread rate (gal/ln-mi) | |
| | | | Liquid MgCl₂ | | Liquid MgCl₂ | |
| Above 32°F , Steady or rising | Dry, wet, slush, or light snow cover | None, see comments | N/R | None, see comments | N/R | *Monitor pavement temperature closely *Treat icy patches if needed with chemical at 15-35 GPLM... plow if needed |
| 32°F , or below is imminent; | Dry | Apply liquid | 15-35 | Plow as needed; reapply liquid chemical when needed | 15-35 | *Application rates will depend on dilution potential |
| <i>ALSO</i> 20 to 32°F , Remaining in range | Wet, slush, or light snow cover | | 20-40 | | 20-40 | |
| 15 to 20°F , Remaining in range | Dry, wet, slush, or light snow cover | | 45-65 | | 45-65 | |
| Below 15°F , Steady or falling | Dry or light snow cover | Plow as needed | N/R | Plow as needed | N/R | * It is not recommended that chemicals be applied in this temperature range * Abrasives can be applied to enhance traction |

CHEMICAL APPLICATIONS: These application rates are starting points. Local experience should refine these recommendations. Time chemical applications to *prevent* deteriorating conditions or development of packed and bonded snow. Monitor temperature and humidity to determine application timing.

PLOWING: Before applying any ice control chemical, the surface should be cleared of as much snow and ice as possible

CHEMICAL RATES: The recommended snow and ice control material application rates depend on atmospheric and pavement conditions at the time of treatment and on how these conditions are expected to change over the time period (window) between the current treatment and the next anticipated treatment.

SOLID DEICER: See Sodium Chloride for application recommendations.

Table 2. Weather event: LIGHT SNOW STORM WITH PERIOD (S) OF MODERATE OR HEAVY SNOW

Using a 30% concentration of Magnesium Chloride

| PAVEMENT TEMPERATURE RANGE, AND TREND | INITIAL OPERATION | | | SUBSEQUENT OPERATIONS | | COMMENTS N/R=Not Recommended |
|---------------------------------------|---|--------------------|----------------------------------|---|----------------------------------|---|
| | Pavement surface at time of Initial operation | Maintenance Action | Chemical spread rate (gal/ln-mi) | Maintenance Action | Chemical spread rate (gal/ln-mi) | |
| | | | Liquid MgCl ₂ | | Liquid MgCl ₂ | |
| Above 32°F, Steady or rising | Dry, wet, slush, or light snow cover | None, see comments | N/R | None, see comments | N/R | *Monitor pavement temperature closely *Treat icy patches if needed with chemical at 15-35 GPLM... plow if needed |
| 32°F, or below is imminent; | Dry | Apply liquid | 15-35 | Plow as needed; reapply liquid chemical when needed | 15-35 | *Application rates will depend on dilution potential |
| ALSO 20 to 32°F, Remaining in range | Wet, slush, or light snow cover | | 20-40 | | 20-40 | |
| 15 to 20°F, Remaining in range | Dry, wet, slush, or light snow cover | | 45-70 | | 45-70 | |
| Below 15°F, Steady or falling | Dry or light snow cover | Plow as needed | N/R | Plow as needed | N/R | * It is not recommended that chemicals be applied in this temperature range * Abrasives can be applied to enhance traction |

CHEMICAL APPLICATIONS: These application rates are starting points. Local experience should refine these recommendations. Time chemical applications to prevent deteriorating conditions or development of packed and bonded snow. Monitor temperature and humidity to determine application timing.

PLOWING: Before applying any ice control chemical, the surface should be cleared of as much snow and ice as possible

CHEMICAL RATES: The recommended snow and ice control material application rates depend on atmospheric and pavement conditions at the time of treatment and on how these conditions are expected to change over the time period (window) between the current treatment and the next anticipated treatment.

SOLID DEICER: See Sodium Chloride for application recommendations.

Table 3. Weather event: *MODERATE OR HEAVY SNOW STORM*

Using a 30% concentration of ***Magnesium Chloride***

| PAVEMENT TEMPERATURE RANGE, AND TREND | INITIAL OPERATION | | SUBSEQUENT OPERATIONS | | COMMENTS | |
|---------------------------------------|---|-----------------------------|---|--|----------|--|
| | Pavement surface at time of Initial operation | Maintenance Action | Chemical spread rate (gal/l _n -mi) Liquid MgCl₂ | Maintenance Action | | Chemical spread rate (gal/l _n -mi) Liquid MgCl₂ |
| Above 32°F, Steady or rising | Dry, wet, slush, or light snow cover | None, see comments | N/R | None, see comments | N/R | N/R=Not Recommended *Monitor pavement temperature closely *Treat icy patches if needed with chemical at 15-35 GPLM plow if needed |
| 32°F, or below is imminent; | Dry | Apply pre-wet solid NaCl | N/R | Plow accumulation and reapply pre-wet solid chemical as needed | N/R | * If sufficient moisture is present, solid chemical without pre-wetting can be applied * Do not apply liquid chemical onto heavy snow accumulation or packed snow |
| ALSO 20 to 32°F, Remaining in range | Wet, slush, or light snow cover | | N/R | | N/R | |
| 15 to 20°F, Remaining in range | Dry, wet, slush, or light snow cover | | N/R | | N/R | |
| Below 15°F, Steady or falling | Dry or light snow cover | Plow accumulation as needed | N/R | Plow accumulation as needed | N/R | * It is not recommended that chemicals be applied in this temperature range * Abrasives can be applied to enhance traction |

CHEMICAL APPLICATIONS: These application rates are starting points. Local experience should refine these recommendations. Time chemical applications to *prevent* deteriorating conditions or development of packed and bonded snow. Monitor temperature and humidity to determine application timing.

PLOWING: Before applying any ice control chemical, the surface should be cleared of as much snow and ice as possible

CHEMICAL RATES: The recommended snow and ice control material application rates depend on atmospheric and pavement conditions at the time of treatment and on how these conditions are expected to change over the time period (window) between the current treatment and the next anticipated treatment.

SOLID DEICER: See Sodium Chloride for application recommendations.

Table 4. Weather event: FROST OR BLACK ICE

Using a 30% concentration of **Magnesium Chloride**

| PAVEMENT TEMPERATURE RANGE, TREND | TRAFFIC CONDITION | INITIAL OPERATION | | SUBSEQUENT OPERATIONS | | COMMENTS |
|--|---|---------------------------|--|-----------------------------------|--|--|
| | | Maintenance Action | Chemical spread rate (gal/l _n -mi) Liquid MgCl₂ | Maintenance Action | Chemical spread rate (gal/l _n -mi) Liquid MgCl₂ | |
| 32°F, Steady or rising | Any level | None, see comments | N/R | None, see comments | N/R | *Monitor pavement temperature closely; begin treatment if temperature starts to fall to 32°F or below and is at or below dew point |
| 28 to 32°F, Remaining in range or falling 32°F or below, and equal to or below dew point | Traffic rate less than 100 vehicles per hour | Apply liquid chemical | 15-35 | Reapply liquid chemical as needed | 15-30 | * Application rates will depend on dilution potential |
| | Traffic rate greater than 100 vehicles per hour | | 20-35 | | 20-35 | |
| 15 to 28°F, Remaining in range, and equal to or below dew point | Any level | | 25-40 | | 25-40 | * Application rates will depend on dilution potential |
| Below 15°F, Steady or falling | | Apply abrasives as needed | N/R | Apply abrasives as needed | N/R | * It is not recommended that chemicals be applied in this temperature range * Abrasives can be applied to enhance traction |

CHEMICAL APPLICATIONS: These application rates are starting points. Local experience should refine these recommendations. Time chemical applications to *prevent* deteriorating conditions or development of packed and bonded snow. Monitor temperature and humidity to determine application timing.

PLOWING: Before applying any ice control chemical, the surface should be cleared of as much snow and ice as possible

CHEMICAL RATES: The recommended snow and ice control material application rates depend on atmospheric and pavement conditions at the time of treatment and on how these conditions are expected to change over the time period (window) between the current treatment and the next anticipated treatment.

Table 5. Weather event: FREEZING RAINSTORM

Using a 30% concentration of **Magnesium Chloride**

Using a 32% concentration of **Calcium Chloride**

Using a 25% concentration of **CMA**

CHEMICAL APPLICATIONS: It is possible to use these chemicals during this event but is not recommended. However, these products can be used through a pre-wet system to increase solid / abrasive efficacy. The application rate for liquids alone would be cost prohibitive and the potential for dilution is high. It is recommended to use a solid chemical application or abrasives.

Using Solid **Sodium Chloride**

| PAVEMENT TEMPERATURE RANGE, AND TREND | INITIAL OPERATION | | SUBSEQUENT OPERATIONS | | COMMENTS |
|---------------------------------------|----------------------|---|----------------------------------|---|---|
| | Maintenance Action | Chemical spread rate (lb/ln-mi) NaCl | Maintenance Action | Chemical spread rate (lb/ln-mi) NaCl | |
| Above 32°F, Steady or rising | None, see comments | N/R | None, see comments | N/R | N/R=Not Recommended * Monitor pavement temperature closely *Treat icy patches if needed with pre-wetted solid chemical at 100--150 lb/lane-mi |
| 32°F, or below is imminent | Apply solid chemical | 100-200 | Reapply solid chemical as needed | 100-200 | *Monitor pavement temperature and precipitation closely * Application rates will depend on dilution potential |
| 20 to 32°F, Remaining in range | | 200-300 | | 200-300 | |
| 15 to 20°F, Remaining in range | | 250-400 | | 250-400 | |
| Below 15°F, Steady or falling | Apply abrasives | N/R | Apply abrasives as needed | N/R | * It is not recommended that chemicals be applied in this temperature range * Abrasives can be applied to enhance traction |

CHEMICAL APPLICATIONS: These application rates are starting points. Local experience should refine these recommendations. Time chemical applications to *prevent* deteriorating conditions or development of packed and bonded snow. Monitor temperature and humidity to determine application timing.

PLOWING: Before applying any ice control chemical, the surface should be cleared of as much snow and ice as possible

CHEMICAL RATES: The recommended snow and ice control material application rates depend on atmospheric and pavement conditions at the time of treatment and on how these conditions are expected to change over the time period (window) between the current treatment and the next anticipated treatment.

Table 6. Weather event: SLEET STORM

Using a 30% concentration of **Magnesium Chloride**

| PAVEMENT TEMPERATURE RANGE, AND TREND | INITIAL OPERATION | | SUBSEQUENT OPERATIONS | | COMMENTS |
|---------------------------------------|--------------------|--------------------------------|--|--------------------------------|--|
| | Maintenance Action | Liquid MgCl₂ | Maintenance Action | Liquid MgCl₂ | |
| Above 32°F, Steady or rising | None, see comments | N/R | None, see comments | N/R | N/R=Not Recommended Go to Sodium Chloride Chart |
| 32°F, or below is imminent | Apply solid NaCl | N/R | Plow accumulation and reapply pre-wet solid chemical as needed | N/R | |
| 28 to 32°F, Remaining in range | | | | | |
| 15 to 28°F, Remaining in range | | | | | |
| Below 15°F, Steady or falling | Plow as needed | N/R | Plow as needed | N/R | |

CHEMICAL APPLICATIONS: These application rates are starting points. Local experience should refine these recommendations. Time chemical applications to *prevent* deteriorating conditions or development of packed and bonded snow. Monitor temperature and humidity to determine application timing.

PLOWING: Before applying any ice control chemical, the surface should be cleared of as much snow and ice as possible

CHEMICAL RATES: The recommended snow and ice control material application rates depend on atmospheric and pavement conditions at the time of treatment and on how these conditions are expected to change over the time period (window) between the current treatment and the next anticipated treatment.

Table 1. Weather event: LIGHT SNOW

Using a 23% concentration of **Sodium Chloride**

| PAVEMENT TEMPERATURE RANGE, AND TREND | INITIAL OPERATION | | | | SUBSEQUENT OPERATIONS | | | COMMENTS N/R=Not Recommended |
|--|---|--|--|-----------------------------|---|--|-----------------------------|---|
| | Pavement surface at time of Initial operation | Maintenance action | Chemical spread rate (gal/l _n -mi or lb/l _n -mi) | | Maintenance action | Chemical spread rate (gal/l _n -mi or lb/l _n -mi) | | |
| | | | Liquid NaCl | Solid or pre-wet solid (lb) | | Liquid NaCl | Solid or pre-wet solid (lb) | |
| Above 32°F , Steady or rising | Dry, wet, slush, or light snow cover | None, see comments | N/R | | None, see comments | N/R | | *Monitor pavement temperature closely *Treat icy patches if needed with chemical at 100 lb/lane-mi; plow if needed |
| 32°F , or below is imminent; | Dry | Apply liquid or pre-wet solid chemical | 40-50 | 75-125 | Plow as needed; reapply liquid or solid chemical when needed | 40-50 | 75-125 | *Application rates will depend on dilution potential |
| <i>ALSO</i> 20 to 32°F , Remaining in range | Wet, slush, or light snow cover | Apply liquid or solid chemical | 40-90 | 100-210 | | 40-90 | 100-210 | |
| 15 to 20°F , Remaining in range | Dry, wet, slush, or light snow cover | Apply pre-wet solid chemical | N/R | 200-240 | Plow as needed; reapply pre-wet solid chemical when needed | N/R | 200-240 | *If sufficient moisture is present, solid chemical without pre-wetting can be applied *Application rates will depend on dilution potential |
| Below 15°F , Steady or falling | Dry or light snow cover | Plow as needed | N/R | | Plow as needed | N/R | | * It is not recommended that chemicals be applied in this temperature range * Abrasives can be applied to enhance traction |

CHEMICAL APPLICATIONS: These application rates are starting points. Local experience should refine these recommendations. Time chemical applications to *prevent* deteriorating conditions or development of packed and bonded snow. Monitor temperature and humidity to determine application timing.

PLOWING: Before applying any ice control chemical, the surface should be cleared of as much snow and ice as possible

CHEMICAL RATES: The recommended snow and ice control material application rates depend on atmospheric and pavement conditions at the time of treatment and on how these conditions are expected to change over the time period (window) between the current treatment and the next anticipated treatment.

Table 2. Weather event: LIGHT SNOW STORM WITH PERIOD (S) OF MODERATE OR HEAVY SNOW

Using a 23% concentration of *Sodium Chloride*

| PAVEMENT TEMPERATURE RANGE, AND TREND | INITIAL OPERATION | | | | SUBSEQUENT OPERATIONS | | | | COMMENTS N/R=Not Recommended | |
|--|---|--|--|------------------------|--|--|--------------|------------------------|-------------------------------------|---|
| | Pavement surface at time of Initial operation | Maintenance Action | Chemical spread rate (gal/l _n -mi or lb/l _n -mi) | | Maintenance Action | Chemical spread rate (gal/l _n -mi or lb/l _n -mi) | | | | |
| | | | Liquid NaCl | Solid or pre-wet Solid | | Liquid NaCl | | Solid or pre-wet solid | | |
| | | | | | | Light snow | Heavier snow | Light snow | | Heavier snow |
| Above 32°F, Steady or rising | Dry, wet, slush, or light snow cover | None, see comments | N/R | | None, see comments | N/R | | | | *Monitor pavement temperature closely *Treat icy patches if needed with chemical at 40-65 GPLM; plow if needed |
| 2°F, or below is imminent; 3 | Dry | Apply liquid or pre-wet solid chemical | 40-65 | 75-150 | Plow as needed; reapply liquid or solid chemical when needed | 40-50 | 50-65 | 75-125 | 150-200 | *Do not apply liquid chemical onto heavy snow accumulation or packed snow * Application rates will depend on dilution potential |
| ALSO 25 to 32°F, Remaining in range | Wet, slush, or light snow cover | Apply liquid or solid chemical | 65-90 | 175-200 | | 65-80 | 80-90 | 175-185 | 190-200 | |
| 15 to 25°F, Remaining in range | Dry, wet, slush, or light snow cover | Apply pre-wet solid chemical | N/R | 200-230 | Plow as needed; reapply pre-wet solid chemical when needed | N/R | | 200-230 | 200-250 | * If sufficient moisture is present, solid chemical without pre-wetting can be applied * Application rates will depend on dilution potential |
| Below 15°F, Steady or falling | Dry or light snow cover | Plow as needed | N/R | | Plow as needed | N/R | | | | * It is not recommended that chemicals be applied in this temperature range * Abrasives can be applied to enhance traction |

CHEMICAL APPLICATIONS: These application rates are starting points. Local experience should refine these recommendations. Time chemical applications to *prevent* deteriorating conditions or development of packed and bonded snow. Monitor temperature and humidity to determine application timing.

PLOWING: Before applying any ice control chemical, the surface should be cleared of as much snow and ice as possible

CHEMICAL RATES: The recommended snow and ice control material application rates depend on atmospheric and pavement conditions at the time of treatment and on how these conditions are expected to change over the time period (window) between the current treatment and the next anticipated treatment.

Table 3. Weather event: MODERATE OR HEAVY SNOW STORM

Using a 23% concentration of **Sodium Chloride**

| PAVEMENT TEMPERATURE RANGE, AND TREND | INITIAL OPERATION | | | SUBSEQUENT OPERATIONS | | | COMMENTS | |
|---------------------------------------|---|--|--|------------------------|--|--|----------|---|
| | Pavement surface at time of Initial operation | Maintenance Action | Chemical spread rate (gal/ln-mi or lb/ln-mi) | | Maintenance Action | Chemical spread rate (gal/ln-mi or lb/ln-mi) | | |
| | | | Liquid NaCl | Solid or pre-wet Solid | | Liquid NaCl | | Solid or pre-wet solid |
| Above 32°F, Steady or rising | Dry, wet, slush, or light snow cover | None, see comments | N/R | | None, see comments | N/R | | *Monitor pavement temperature closely *Treat icy patches if needed with chemical at 40-65 GPLM; plow if needed |
| 32° F, or below is imminent; | Dry | Apply liquid or pre-wet solid chemical | 40-65 | 75-150 | Plow accumulation and reapply liquid or pre-wet solid chemical as needed | 50-65 | 150-200 | *Do not apply liquid chemical onto heavy snow accumulation or packed snow * Application rates will depend on dilution potential |
| ALSO 25 to 32°F, Remaining in range | Wet, slush, or light snow cover | Apply solid chemical | N/R | 175-200 | Plow accumulation and reapply pre-wet solid chemical as needed | 80-90 | 190-200 | |
| 15 to 25°F, Remaining in range | Dry, wet, slush, or light snow cover | Apply pre-wet solid chemical | N/R | 200-230 | Plow as needed; reapply pre-wet solid chemical when needed | N/R | 200-250 | * If sufficient moisture is present, solid chemical without pre-wetting can be applied * Application rates will depend on dilution potential |
| Below 15°F, Steady or falling | Dry or light snow cover | Plow as needed | N/R | | Plow as needed | N/R | | * It is not recommended that chemicals be applied in this temperature range * Abrasives can be applied to enhance traction |

CHEMICAL APPLICATIONS: These application rates are starting points. Local experience should refine these recommendations. Time chemical applications to *prevent* deteriorating conditions or development of packed and bonded snow. Monitor temperature and humidity to determine application timing.

PLOWING: Before applying any ice control chemical, the surface should be cleared of as much snow and ice as possible

CHEMICAL RATES: The recommended snow and ice control material application rates depend on atmospheric and pavement conditions at the time of treatment and on how these conditions are expected to change over the time period (window) between the current treatment and the next anticipated treatment.

Table 4. Weather event: FROST OR BLACK ICE

Using a 23% concentration of **Sodium Chloride**

| PAVEMENT TEMPERATURE RANGE, TREND | TRAFFIC CONDITION | INITIAL OPERATION | | SUBSEQUENT OPERATIONS | | COMMENTS | | |
|---|--|--|--|------------------------|--|----------|--|--|
| | | Maintenance Action | Chemical spread rate (gal/l ⁿ -mi or Lb/l ⁿ -mi) | | Maintenance Action | | Chemical spread rate (gal/l ⁿ -mi or lb/l ⁿ -mi) | |
| | | | Liquid NaCl | Solid or pre-wet solid | | | Liquid NaCl | Solid or pre-wet solid |
| 32°F, Steady or rising | Any level | None, see comments | N/R | | None, see comments | N/R | | *Monitor pavement temperature closely; begin treatment if temperature starts to fall to 32°F or below and is at or below dew point |
| 28 to 32°F, Remaining in range or falling 32°F or below, and equal to or below dew point | Traffic rate less than 100 vehicles per h | Apply liquid or pre-wet solid chemical | 45-60 | 100-130 | Reapply liquid or pre-wet solid chemical when needed | 45-60 | 100-130 | * Application rates will depend on dilution potential |
| | Traffic rate greater than 100 vehicles per h | | 45-75 | 100-130 | | 45-75 | 100-130 | |
| 20 to 28°F, Remaining in range, and equal to or below dew point | Any level | | 65-80 | 165-200 | | 65-80 | 165-200 | |
| 15 to 20°F, Remaining in range, and equal to or below dew point | | Apply pre-wet solid chemical | N/R | 175-225 | Reapply pre-wet solid chemical when needed | N/R | 175-225 | |
| Below 15°F, Steady or falling | | Apply abrasives | N/R | | Apply abrasives as needed | N/R | | * It is not recommended that chemicals be applied in this temperature range * Abrasives can be applied to enhance traction |

CHEMICAL APPLICATIONS: These application rates are starting points. Local experience should refine these recommendations. Time chemical applications to *prevent* deteriorating conditions or development of packed and bonded snow. Monitor temperature and humidity to determine application timing.

PLOWING: Before applying any ice control chemical, the surface should be cleared of as much snow and ice as possible

CHEMICAL RATES: The recommended snow and ice control material application rates depend on atmospheric and pavement conditions at the time of treatment and on how these conditions are expected to change over the time period (window) between the current treatment and the next anticipated treatment.

Table 5. Weather event: FREEZING RAINSTORM

Using a 30% concentration of **Magnesium Chloride**

Using a 32% concentration of **Calcium Chloride**

Using a 25% concentration of **CMA**

CHEMICAL APPLICATIONS: It is possible to use these chemicals during this event but is not recommended. However, these products can be used through a pre-wet system to increase solid / abrasive efficacy. The application rate for liquids alone would be cost prohibitive and the potential for dilution is high. It is recommended to use a solid chemical application or abrasives.

Using Solid **Sodium Chloride**

| PAVEMENT TEMPERATURE RANGE, AND TREND | INITIAL OPERATION | | SUBSEQUENT OPERATIONS | | COMMENTS |
|---------------------------------------|----------------------|---|----------------------------------|---|--|
| | Maintenance Action | Chemical spread rate (lb/ln-mi) NaCl | Maintenance Action | Chemical spread rate (lb/ln-mi) NaCl | |
| Above 32°F, Steady or rising | None, see comments | N/R | None, see comments | N/R | N/R=Not Recommended * Monitor pavement temperature closely * Treat icy patches if needed with pre-wetted solid chemical at 100--150 lb/lane-mi |
| 32°F, or below is imminent | Apply solid chemical | 100-200 | Reapply solid chemical as needed | 100-200 | * Monitor pavement temperature and precipitation closely * Application rates will depend on dilution potential |
| 20 to 32°F, Remaining in range | | 200-300 | | 200-300 | |
| 15 to 20°F, Remaining in range | | 250-400 | | 250-400 | |
| Below 15°F, Steady or falling | Apply abrasives | N/R | Apply abrasives as needed | N/R | * It is not recommended that chemicals be applied in this temperature range * Abrasives can be applied to enhance traction |

CHEMICAL APPLICATIONS: These application rates are starting points. Local experience should refine these recommendations. Time chemical applications to prevent deteriorating conditions or development of packed and bonded snow. Monitor temperature and humidity to determine application timing.

PLOWING: Before applying any ice control chemical, the surface should be cleared of as much snow and ice as possible

CHEMICAL RATES: The recommended snow and ice control material application rates depend on atmospheric and pavement conditions at the time of treatment and on how these conditions are expected to change over the time period (window) between the current treatment and the next anticipated treatment.

Table 6. Weather event: SLEET STORM

Using a 23% concentration of **Sodium Chloride**

| PAVEMENT TEMPERATURE RANGE, AND TREND | INITIAL OPERATION | | SUBSEQUENT OPERATIONS | | COMMENTS |
|---------------------------------------|----------------------|--|--|--|--|
| | Maintenance Action | Chemical spread rate, lb/lane-mi NaCl | Maintenance Action | Chemical spread rate, lb/lane-mi NaCl | |
| Above 32°F, Steady or rising | None, see comments | N/R | None, see comments | N/R | N/R=Not Recommended * Monitor pavement temperature closely *Treat icy patches if needed with pre-wetted solid chemical at 100-150 lb/lane-mi |
| 32°F, or below is imminent | Apply solid chemical | 125 | Plow accumulation and reapply pre-wet solid chemical as needed | 125 | *Monitor pavement temperature and precipitation closely * Application rates will depend on dilution potential |
| 28 to 32°F, Remaining in range | | 125-325 | | 125-325 | |
| 15 to 28°F, Remaining in range | | 250-400 | | 250-400 | |
| Below 15°F, Steady or falling | Plow as needed | N/R | Plow as needed | N/R | * It is not recommended that chemicals be applied in this temperature range * Abrasives can be applied to enhance traction |

CHEMICAL APPLICATIONS: These application rates are starting points. Local experience should refine these recommendations. Time chemical applications to *prevent* deteriorating conditions or development of packed and bonded snow. Monitor temperature and humidity to determine application timing.

PLOWING: Before applying any ice control chemical, the surface should be cleared of as much snow and ice as possible

CHEMICAL RATES: The recommended snow and ice control material application rates depend on atmospheric and pavement conditions at the time of treatment and on how these conditions are expected to change over the time period (window) between the current treatment and the next anticipated treatment.