

SECTION NINE

TREATMENTS FOR SNOW AND ICE



In association with IHE

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KEY

Red text are warnings or especially important information

Green text are particular recommendations or key advantages to consider

CHECK LIST:

Do you treat in advance of snowfall and freezing rain in order to provide a debonding layer?

Do the plough types and set up allow ploughing down to the road surface (ploughing to black)?

Are drivers trained in correct plough operation, including effective ploughing strategies and, if appropriate, ploughing to black?

Are operational plans in place so ploughs are easily available and ready for fitting?

SECTION NINE

Treatments for Snow and Ice Cold

9.1 INTRODUCTION

9.1.1 This section provides guidance on effective treatments for snow, ice and freezing rain based on the operational experience of practitioners and in combination with a review of the available research and literature.

Further guidance on planning for snow events and prioritising the treated network is available in the 'Planning' and 'Route Selection and Optimisation' NWSRG Practical Guidance Sections.

9.1.2 Whenever practicable, it is crucial that de-icer is spread on road surfaces before snowfall and freezing rain occurs. This provides a layer which prevents the snow and ice bonding to the road surface (debonding layer) and this aids subsequent treatments.

9.1.3 It is impractical to spread sufficient salt to melt anything other than very thin layers of snow and ice, and ploughing (or, in certain circumstances, cutting and blowing) is the only effective way to deal with more than a few millimetres of snow.

9.1.4 The most effective ploughing technique is to plough down to the road surface ('Ploughing to black'), as this removes almost all of the lying snow and minimises the amount of de-icer required for subsequent treatments. Equipment designed for this purpose is available from manufacturers but the technique may not be suitable for all road surface types and/or conditions.

Therefore, authorities should assess the suitability of ploughing down to the road surface for their networks and, if practicable and appropriate, employ this technique during their snow clearance operations.

9.1.5 Preparation is essential - ploughs must be readied and in position before heavy snowfall if ploughing is to be effective.

9.2 OPTIMUM TREATMENTS FOR SNOW AND FREEZING RAIN

9.2.1 The factors which determine the optimum treatment include:

- The amount and intensity of snow or freezing rain forecast.
- The timing of both the predicted event and the remedial treatment.
- The effect of trafficking.
- The practicality of ploughing (for snow).

The effects of these factors on the decision making process are described in the following sections.

9.2.2 Particular care should be taken to manage the risks to personnel carrying out winter service operations in snow and freezing rain conditions.

9.3 LEVELS OF SNOWFALL

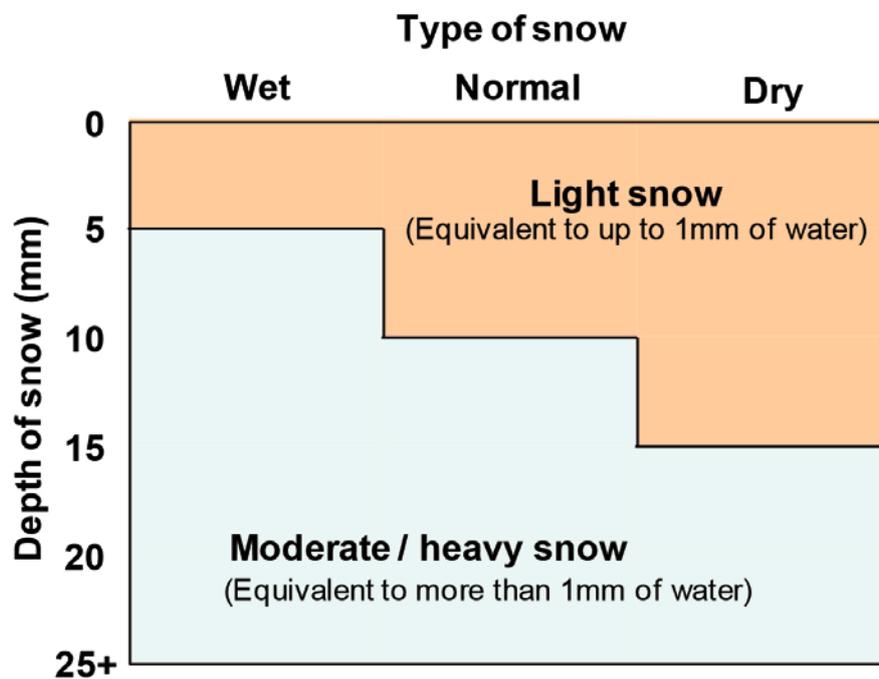
9.3.1 Based around three types of snow: **dry** (powdery), **normal** and **wet** this guide uses two categories of snow intensity: **light snow** and **moderate/heavy snow** for the purposes of allocating treatments.

Typically, 10mm depth of snow will contain the equivalent of approximately 1mm depth of liquid water. However, the ratio varies with the type of snow, and the same amount of surface water is present in approximately 5mm depth of 'wet' snow and 15mm of 'dry / powdery' snow.

9.3.2 Authorities considering this to be an important aspect of decision making may request their weather forecast service provider to provide information concerning the snow "wetness" factor in their predictions.

9.3.3 The highest spread rate used by most authorities for dry salting is 40g/m² (although it is recognised that delivering this onto the road surface may require more than one treatment). This spread rate, combined with the effect of trafficking, should be sufficient to melt and disperse snow depths which are equivalent to a maximum of 1mm of water at temperatures down to -2°C but will not be sufficient to melt heavier snow.

Therefore, in this guide, 'light' snow is taken to be snow equivalent to 1mm of water (or less) while snowfalls equivalent to more than 1mm are considered to be moderate to heavy, as shown in the diagram 9.3.2 below.



9.4 TIMING OF TREATMENTS

- 9.4.1 When snow is forecast and issues of practicality allow, ploughs and snow blowers should be made ready to allow snow clearance to commence without delay as and when required. The recommended aim is to apply a precautionary treatment to the salting network immediately prior to snow fall or freezing rain, as this should significantly reduce the risks of snow settling or ice forming on the road surface.
- 9.4.2 When feasible, treatments should be carried out after any preceding rainfall has ceased and sufficient time and traffic has removed excess water on the road surface. It is, however, recognised that there may be insufficient time during the intervening period to undertake a full precautionary salting operation. These situations are some of the most difficult of all to deal with and, whenever snowfall or freezing rain is expected, decision makers will need to carefully consider the most appropriate and effective timing for operations. In some circumstances, treatments may be required to be undertaken during rainfall or on very wet road surfaces and repeat treatments may be required to prevent compacted snow or icy conditions occurring as snow continues to fall.
- 9.4.3 When snow is settling, ploughing should be carried out at an early enough point to prevent its compaction by traffic. During prolonged snowfall events and when issues of practicality allow, the time periods between successive ploughing passes necessary to prevent a build-up of snow should be kept short enough so that compaction is minimised. In some instances, this may require continuous ploughing operations.
- 9.4.4 Authorities should recognise that treating the network during periods of snowfall or freezing rain poses risks to their staff, as well as to the public. Therefore, risk assessments should be undertaken to ensure that these risks are appropriately accounted for and clearly communicated.

Depending on the prevailing conditions, subsequent treatments should be carried out as shown below:

TABLE 9.4.4 Timing of treatment	Treatment type
During freezing rain, or where there are minor accumulations of ice	Salt spreading ¹
During snowfall	Ploughing and salt spreading
After snowfall <ul style="list-style-type: none"> ● When there is slush on the road ● When there is compacted layers of snow and ice 	Ploughing and salt spreading Salt and abrasive mixtures or just abrasives can be used on compacted layers of snow and ice

¹ In accordance with risk assessments

9.5 FREEZING RAIN – DEFINITION AND IMPORTANT CONSIDERATIONS

- 9.5.1 Freezing rain is a relatively rare, but hazardous phenomenon in the UK, as the nature of freezing rain means that the risk of ice formation is high, even on treated surfaces. The formal meteorological definition of freezing rain relates to situations when rain falls through a layer of very cold air in the atmosphere and becomes super-cooled, remaining as a liquid below the usual freezing temperature. When the rain strikes a surface, it freezes to form glaze ice almost immediately on contact.
- 9.5.2 Rain that is not super-cooled but falling onto a surface that is itself significantly below zero Celsius can also freeze rapidly after contact although, in this instance, the ice is likely to take a short time to form as the temperature of the water decreases.
- 9.5.3 In common use, the term ‘freezing rain’ can be used to describe either of the above scenarios and authorities should liaise with their weather forecast service providers to ensure they have a clear and mutually agreed understanding of the precise scope of the term ‘freezing rain’ when used in the purchased weather forecasts. Part of the reason for this is that pre-treatments can sometimes provide a more effective treatment against ice forming in those situations that do not involve super-cooled rain.
- 9.5.4 When either of these situations are forecast, authorities should aim to pre-treat, and careful monitoring throughout the event is also important. Subject to the authority’s policies and risk assessments confirming that the risk levels to operational staff are acceptable, treatments may then be continued until such time that the risk of ice formation has passed due to the cessation of rainfall or the road surface temperature rising above freezing.
- 9.5.4 In these situations, as the risk of ice formation remains high despite the best attempts of authorities to reduce it, advance warnings to road users can be particularly valuable. Authorities may therefore wish to consider liaising with local media services and/or using social media outlets etc to publicise these. In addition, those authorities that operate roadside variable message signage may choose to utilise this to provide further warnings.

9.6 TYPES OF SNOW PLOUGH

- 9.6.1 A wide range of snow plough types are available, including those for mounting on salting vehicles and other maintenance vehicles. Where appropriate, it is recommended that ploughing should be carried out down to the road surface and snow ploughs are available that are designed to achieve this without causing damage to the road surface.
- 9.6.2 The important aspects to consider on a plough are:
- The material used for the wearing edge of the plough blade
 - The construction of the plough
 - The ease of mounting and removal (where applicable)
- 9.6.3 Plough blades are available with different types of wearing edge material, including rubber, polyurethane, metal and composite materials. Rubber wearing edges can offer an effective ‘squeegee’ action that removes soft snow and slush. However, rubber wearing edges are likely to be less effective than harder wearing edges at removing hard packed snow and ice. Ploughs specifically designed for removing compacted snow or ice will have metal cutting edges. Weak materials should not be used as wearing edges.
- 9.6.4 The type of ploughs used on the highway network are typically straight bladed, and it is often possible to change the angle at which the blade is oriented to the left or right and the angle of the plough blade to the road surface.

- 9.6.5 Steerable snow ploughs, in which the blade orientation can be changed automatically during clearing operations, provide even greater operational flexibility. For example, when clearing snow to the roadside with an angled plough, there may be occasions when it is necessary to alter the angle of the blade, for example to move snow along a road when there is insufficient room to the side, or there is a need to avoid blocking certain areas.
- 9.6.6 The correct plough orientation should be used for the intended purpose:
 - Straight blade angled to the road alignment - for displacing snow/slush to the roadside
 - Straight blade perpendicular to the road alignment - for moving snow along a road
 - V shaped – typically for displacing deep snow to both sides of the vehicle
- 9.6.7 Blades can be formed from several sections, mounted side by side, with each section able to move independently. This allows the blades to better adapt to the shape of the road surface. Some types of plough are constructed with a single section blade and these may be less effective in certain circumstances than multiple section blades.
- 9.6.8 Ploughs should have an effective security system to avoid damage to the machine, the road surface and the blade - for example spring mounted wearing edges which can deflect when an obstacle is encountered. A float mechanism enables the plough blade to automatically follow the changing longitudinal profile of the road, preventing the whole weight of the vehicle being applied to the plough and reducing wear to the plough blade.
- 9.6.9 The plough should be easily mountable, to minimise the time and manpower required to mobilise the plough, potentially shortening response times.
- 9.6.10 A range of plough types are available for mounting on other maintenance vehicles. In addition to the spreading fleet, consideration should be given to fitting ploughs to other vehicles including those belonging to contractors or farmers. This will increase the capacity for ploughing on an authority's network and potentially free up salting vehicles to spread de-icer and/or abrasives to assist in providing a faster and more effective service in snow conditions.

9.7 SNOW PLOUGHING STRATEGIES

- 9.7.1 The purpose of ploughing is to move as much snow as possible away from the road surface. More than a few millimetres of snow cannot be treated with salt.
- 9.7.2 Effective ploughing will:
 - Remove as much snow as is practical for the given conditions, preferably down to the road surface
 - Reduce the likelihood of snow becoming compacted and bonded to the road surface
 - Reduce the amount of de-icer needed for subsequent treatments (these treatments may not be effective if much snow has fallen and not been removed by ploughing)

Some of the potential advantages and disadvantages of ploughing down to the road surface are provided below:

TABLE 9.7.2 'PLOUGHING TO BLACK'

Potential Advantages	Potential Disadvantages
Better driving surface	Incompatible with some ploughing equipment and risks require adequate management
Less de-icer required to be spread on ploughed surface¹	Potential for damage to road infrastructure, e.g. cats eyes
Fewer passes to achieve bare pavement	Increased wear rate of some blade edge types
Spreaders available for secondary routes sooner	<i>Vibration on rough surfaces</i>

¹This may not reduce spread rates used for each treatment pass, but may require fewer further treatments

- 9.7.3 Careful choice of equipment and appropriate staff training are crucial to mitigating the risks associated with all snowploughing activities, and this is particularly important when ploughing down to the road surface.
- 9.7.4 Winter Service Plans should clearly outline the conditions (trigger points) for mounting ploughs on spreaders and other maintenance vehicles e.g. a forecast of significant accumulations in next 24 hours. This should be decided route by route locally.
- 9.7.5 If additional resource is provided by use of ploughs on non-spreading vehicles, this must be coordinated with other treatments from the spreading fleet. The requirements for follow up treatments on sections that are ploughed by non-spreading vehicles should be documented in the winter service plan.
- 9.7.6 Dependant on local/route risk, specific plans should be drawn up for each ploughing route to inform drivers where ploughed snow can and cannot be moved to. Some key considerations include:
- Snow should be ploughed to the low side of carriageways and the build-up of snow in the centre of a single carriageway should be avoided. This is to avoid the later run-off from windrows or piles of snow from entering the traffic lanes, where it may dilute treatments and/or refreeze
 - Drainage should be kept clear, and windrows or piles of snow should be removed or be positioned to allow melt water to reach the drains
 - Piles of snow should be removed, where possible, so that melted snow does not overload drainage systems or run back onto the road and refreeze to form sheet ice, particularly where drainage is blocked or piles of snow are to the high side of the road
 - Windrows must be avoided at level crossings. Before ploughing commences on roads that include level crossings, contact should be made with Network Rail (Translink in Northern Ireland)
 - Windrows should be removed or ploughed back when further periods of heavy snow are anticipated. This will provide space to plough the further snowfalls
 - Accumulations of snow at central reserves, especially those with vertical concrete barriers, should be cleared where they create a hazard or impede drainage
- 9.7.7 Where possible, dual carriageways and motorways should be ploughed in one pass, either by:
- Ploughing just one lane
 - Ploughing all lanes using multiple ploughs working in echelon formation
 - Appropriate traffic management should be considered

9.8 TREATMENTS BEFORE SNOWFALL AND FREEZING RAIN

- 9.8.1 It can be very difficult to remove a layer of compacted snow or ice that is bonded to a road surface and a debonding layer is important so that:
- Snow is more readily removed by ploughing
 - Compacted snow and ice are more easily dispersed by traffic
 - To provide salt to melt small quantities of light snow with the aid of trafficking
- 9.8.2 Consideration should be given to the extent of the network that will be treated in response to predictions of snowfall and freezing rain. Guidance on this is provided in the 'Route Selection and Optimisation' Section of the NWSRG Guide.
- 9.8.3 Guidance relating to the range of recommended spread rates for these conditions is provided below. However, it should be recognised that definitive and/or precise recommendations in this regard are not possible because of the large variations that can occur in the amount of snow, its water content and the effects of traffic. It is also recognised that, for many authorities, the maximum spread rate achievable in a single pass of a salting vehicle will be no more than 20g/m².
- 9.8.4 The key recommendation is that one treatment within the range of spread rates is completed before snow occurs. As noted in Section 9.4 above, this may sometimes require spreading during rainfall with repeat treatments as necessary.
- 9.8.5 Where there is only a short time available, options can include mobilising the front line and reserve fleets where available to work in tandem. In such a case, two vehicles can spread a route at half the specified rate, and when a vehicle needs to reload the other vehicle continues spreading at the full rate.

Potential treatment rates to use before snowfall and freezing rain are outlined in Matrix 9.8.

TREATMENT MATRIX 9.8.5 TREATMENTS BEFORE SNOWFALL AND FREEZING RAIN

Weather conditions

Light to Moderate/Heavy snow forecast	Spread: <ul style="list-style-type: none"> ● 20-40g/m² of dry salt, or ● 20-40g/m² of pre-wetted salt, or ● 15-30g/m² of treated salt
Freezing rain forecast	<ul style="list-style-type: none"> ● 40 or 2x20g/m² of dry salt, or ● 40 or 2x20g/m² of pre-wetted salt, or ● 30 or 2x15g/m² of treated salt

Note 1: In situations where time constraints dictate, a treatment of 20g/m² across the whole of the scheduled network before the commencement of snowfall or freezing rain will typically prove more advantageous than a treatment of 40g/m² on only part of the network.

9.9 TREATMENTS DURING SNOW AND FREEZING RAIN

9.9.1 Treatments are undertaken during snowfall to:

- Limit the accumulation of snow on the road surface, thereby reducing the amount of salt required for subsequent treatments
- Help the dispersal/clearing of the snow by traffic
- Prevent snow from being compacted

The combination of ploughing and de-icer treatments should be as in Matrix 9.9.1

TREATMENT MATRIX 9.9.1 TREATMENTS DURING SNOW AND FREEZING RAIN

Plough to remove as much material as possible e.g. slush, snow, compacted snow
 Ploughing should be down to the level of the road surface
 Ploughing should start and, where necessary, be continuous to prevent a build-up of snow
 As snow melts under the action of salt, keep ploughing to remove slush

No ice or compacted snow on surface	Ice or compacted snow on surface	
To provide a debonding layer, spread: <ul style="list-style-type: none"> ● 20-40g/m² of dry salt, or ● 15-30g/m² of treated salt or ● 20-40g/m² of pre-wetted salt 	Is traffic likely to compact subsequent snowfall before further ploughing is possible?	
	YES	NO
	To provide a debonding layer, spread: <ul style="list-style-type: none"> ● 20-40g/m² of dry salt, or ● 15-30g/m² of treated salt or ● 20-40g/m² of pre-wetted salt 	No de-icer should be spread

9.9.2 De-icer should not be spread alone without abrasives to anything other than a thin layer of ice or compacted snow when snowfall has ceased or future snowfall will be less than 10mm. Applying salt alone to compacted snow and ice can produce dangerously slippery conditions if a weak brine film is formed on top of the ice/snow layer.

9.10 TREATMENTS OF THIN ICE LAYERS

- 9.10.1 Treatments using salt or salt and abrasive mixes should be made in accordance with Matrix 9.10.4
- 9.10.2 For best performance, abrasives should be 5-6mm and angular. Salt and abrasive should be pre-mixed before loading onto the spreader (see below). The mix proportions should be approximately 50:50 by weight (similar to 50:50 by volume) – i.e. one loader bucket full of salt to one loader bucket of abrasive.
- 9.10.3 Care is needed when salt is mixed with abrasives. Checks should be made that the mixture is free flowing, does not clump and can be spread effectively.
- 9.10.4 On some spreaders, it is possible to place a baffle board in the spreader hopper so that salt is placed on one side of the hopper and abrasives on the other. The baffle board can be positioned so the belt is loaded with salt and abrasives in the correct proportions for mixing at the spinner during spreading.

After abrasives have been used, drainage systems should be checked and cleared if necessary. Recovered material, which will be contaminated with road oil, must be disposed of safely.

TREATMENT MATRIX 9.10.4 TREATMENT FOR THIN LAYERS OF ICE (LESS THAN ABOUT 1MM THICK)	
Forecast weather and road surface conditions	
Lower of air or road surface temperature Above -5°C	Spread: <ul style="list-style-type: none"> ● 40g/m² of dry salt, treated salt or pre-wetted salt, or ● 40g/m² of salt/abrasive mix
Lower of air or road surface temperature At or below -5°C	Spread: <ul style="list-style-type: none"> ● 40g/m² of salt/abrasive mix (50:50)
Note 1: Salt is ineffective in the short term at temperatures below -7°C. Abrasives only should be used when it is expected to be below -7°C for long periods. Other de-icers are available for low temperatures (see De-icer Types Section).	

9.11 TREATMENT OF COMPACTED LAYERS OF SNOW AND ICE

- 9.11.1 Treatments should be made in accordance with Matrix 9.11.3
- 9.11.2 For compacted snow, when no further snow is expected, salt and abrasive mixtures or abrasives are applied to assist the action of traffic in breaking the layer. When further snow is expected, salt and abrasive mixtures treatments may be applied to provide grip as well as a debonding layer between the existing layer and any future snow to assist future ploughing operations.
- 9.11.3 Salt should not be applied on its own as it may eventually form a weak brine solution which may re-freeze to form an ice or ice/brine layer.

TREATMENT MATRIX 9.11.3 TREATMENT FOR LAYERS OF COMPACTED SNOW AND ICE	
Plough to remove as much material (e.g. slush, snow, compacted snow) as possible from the top of the compacted layer	
Medium Layer Thickness (1 to 5 mm)	High Layer Thickness (greater than 5mm)
For initial treatment, spread: <ul style="list-style-type: none"> ● 40g/m² of salt/abrasive mix (50:50) For successive treatments, spread: <ul style="list-style-type: none"> ● 20g/m² of salt/abrasive mix (50:50) 	For initial treatment, spread: <ul style="list-style-type: none"> ● 40g/m² of abrasives only For successive treatments, spread: <ul style="list-style-type: none"> ● 20g/m² of abrasives only After traffic has started breaking up the layer, spread: <ul style="list-style-type: none"> ● 20g/m² of salt/abrasive mix (50:50) so salt can penetrate the layer and reach the road surface

