PART 5 - WINTER SERVICE

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5.1 Introduction to Winter Service

This chapter provides guidance, advice and instruction to Service Providers for the delivery of an effective winter service. Service Providers demonstrate their preparedness for this by developing a Severe Weather Plan, which replaces and now includes what was previously covered by the Winter Service Plan. This is a mandatory requirement and has been included in a text box - see 5.2.1. For editing purposes other mandatory requirements contributing to that Severe Weather Plan are not included within text boxes and for this reason, some mandatory terms within this Chapter appear outside text boxes.

5.1.1 Legal Duty

The Service Provider must plan all winter services such that they meet all statutory requirements. The nature of the operation will invariably call for a degree of judgement, but that judgement may have to be defended in a court of law so it should be sound and recorded.

To reflect this, Section 41(1A) of the Highways Act 1980 was inserted on 31 October 2003, by Section 111 of the Railways and Transport Act 2003. The first part of Section 41 now reads:

(1) The authority who are for the time being a highway authority for a highway maintainable at public expense are under a duty subject to subsections (2) and (4) below, to maintain the highway

(1A) In particular, a highway authority is under a duty to ensure, so far as is reasonably practicable, that safe passage along the highway is not endangered by snow or ice.

5.1.2 Level of Service

The minimum standards to be achieved for winter service are given in section 2.18 of the Routine and Winter Service Code.

The Service Provider must prepare the Severe Weather Plan in order to deliver the winter service and performance standards required by the Code. As a minimum this must be:

Response and Treatment Times

Response time is **1 hour**. Response time is defined as the maximum time taken from the decision to begin treatment until the winter service vehicles are loaded, manned and ready to leave the compound.

Treatment time is **2 hours** Treatment time is defined as the maximum time taken from leaving the compound through to returning to the compound after completion of the treatment route.

5.1.3 Winter Period

Unless otherwise agreed with the Service Manager the Winter Period from 1st October to 30th April is that during which the Service Provider must be fully prepared to undertake winter services. During this time, three risk periods are identified for operational purposes:

Risk	Months
High	December, January and February
Low	November and March
Marginal	October and April

The actual dates for the winter period may vary from year to year and the Service Provider must agree with the Service Manager by 1st July each year, the requirements for standby and /or continuous shift arrangements within each risk period. The Severe Weather Plan must include the agreed dates.

5.1.4 Role of the Highways Agency's Traffic Officer Service

The Traffic Officer Service provides an additional source of information on the state of the network in relation to traffic flow, weather and road conditions such as ice, freezing rain and snow accumulations and reports this through the Regional Control Centres.

The Traffic Officer Service may also offer a variety of support when requested by Service Providers, if operationally available. Such tasks could include aiding access for winter service vehicles through congestion, negotiating diversions and road works where Traffic Officer powers in directing traffic would be beneficial.

The potential support available is detailed in the Traffic Officer Procedures.

Service Providers must provide short winter and severe weather briefing sessions each year to the Traffic Officer Service in line with requirements in Annex 5.1.1. All briefings are to be completed by the end of October. Briefings are to be aimed at Traffic Officers and Regional Control Centre supervisors who will be responsible for cascading the information to staff during shift briefings.

The Traffic Officer Service will also take an active role in pre-winter snow desk exercises along with other winter service stakeholders.

5.1.5 Winter and Business Continuity Reporting

5.1.5.1 Introduction

Service Providers must use the winter and business continuity reporting system (WRF1) provided by the Highways Agency. The reporting system is Internet based and hosted by Atkins at the following address: http://winter.atkinsglobal.com/winter.

5.1.5.2 Access Requirements

Service Providers should review user access to the WRF1 system (data entry and read-only) and provide details of new users and historic accounts to be closed to wm_nart@highways.gsi.gov.uk.

At their discretion Service Providers should request individual user names and passwords for stakeholders to allow read-only access to the system. A valid email account is required for those stakeholders who require automatic notification of WRF1 reports.

5.1.5.3 Additional Services

Atkins will provide a call centre facility to enable Service Providers to submit winter service decisions in the event of system failure. The telephone number of this call centre is: 0870 2411538. This service is available 24 hours a day seven days a week (including Bank Holidays) throughout the winter season.

However, Service Providers are still required to ensure that a backup facsimile system can be implemented in case of such a failure. (Manual reports should be faxed to the Highways Agency using 0121 678 8510).

5.1.5.4 Winter Reporting

Service Providers must use the on-line electronic winter reporting system (WRF1).

Service Providers must keep the WRF1 system up to date during the Winter Period with the state of the Network and treatment decisions to ensure that the information is a true and accurate representation of the current situation.

The WRF1 system has two objectives:

1. Record of Decisions – The WRF1 system will provide the Highways Agency, it's Service Providers, Traffic Officer Service, local authorities, police services and other winter stakeholders with up-to-date information on the state of the network, business continuity and weather related incidents.

2. Confirmation of Treatments – The WRF1 system will provide the National Winter Team and NetServe with information to allow them to take a strategic overview of the network. The data is also used to assist in the measurement of performance and is used to inform various research projects.

To satisfy the first objective, Service Providers are reminded that the WRF1 is a "live" system and therefore they must record their winter service decisions, within 30 minutes of making them, as and when conditions change on the Network seven days a week. As a minimum reporting requirement, by 16:00 hrs a Full Report must be recorded on WRF1 which details the proposed actions to be undertaken by the Service Provider. If there has been no change to the Service Providers' decisions over the previous 24 hour period, then a "No Change" report must be recorded.

To satisfy the second objective, an Update Report must be recorded on WRF1 to confirm all the actions undertaken by the Service Provider since the submission of the last Full Report. As a minimum reporting requirement this must be completed by 10:00 hrs on the following day.

The information recorded on WRF1 will be used to inform the Highway Agency's management of the state of the network. It is essential therefore that submitted reports reflect the true conditions of the network and are not simply updates of the weather.

Service Providers will be able to enter treatments in any denomination, not just 10, 20, or 40gms/m².

Where multiple treatments are proposed, Service Providers should select '*Multiple'* from the available treatment options and record the time of the first treatment. When the last treatment has been completed, Service Providers should submit a second report selecting *Completed* from the treatment options and recording the time when it was completed.

Service Providers will only be required to provide Road Surface Temperatures, air temperatures are no longer required.

Detailed information on non-weather related incidents are not required on the WRF1 system (other than to note that the route is affected by an incident).

Archived information can be easily accessed for winter season audit reviews.

There will be a direct link from WRF1 to the Highways Agency website.

Records may be used for hot or cold de-briefs and therefore it is essential that the recorded information is complete and accurate.

5.1.5.5 Winter Reporting during Severe Weather Desk (Adverse Weather) Conditions

During Severe Weather Desk situations an Adverse Weather Report must be recorded by the Service Provider on WRF1. This is a simplified report, reducing reporting requirements during such periods of increased activity, and the frequency of submission on WRF1 should be in accordance with the Service Provider's Severe Weather Plan. This reporting regime will remain in place until the Service Provider stands the Severe Weather Desk down.

5.1.5.6 Business Continuity Reporting

Service Providers must also submit a Business Continuity Report on WRF1 by 16:00hrs on a daily basis during the Winter Period. As a minimum reporting requirement, salt stock capability and reserve fleet levels should be recorded. When there is a possibility of fuel disruption, compound fuel status should also be recorded.

There are three basic reports that require completion; salt stock capability levels, compound fuel levels and reserve fleet details. Details for completion of each report are as follows:

- Salt Stock Capability Levels

  The purpose of monitoring salt stock levels is to provide an early warning system to allow critical stock levels to be identified. Daily salt stock monitoring is essential so that any stock issues are addressed to ensure operational resilience. It is required that decimal values be rounded down to the nearest whole number. Comprehensive guidance on salt stock monitoring and reporting can be found in Section 5.1.6 and Annex 5.1.2.

- Compound Fuel Levels

  In accordance with paragraph 2.2.3.2 of the Severe Weather Plan template, Service Providers are required to monitor fuel stock levels regularly during the Winter Period.

  When there is a possibility of disruption of fuel supply or when stocks are low then the Service Provider should use the WRF1 reporting system to highlight the situation to the Highway Agency and other areas in order for the situation to be reviewed. The system is based on a red, amber and green rating. Fuel levels are expected to remain green until such time that the Service Provider feels service resilience is under threat. An amber alert should be activated when the Service Provider becomes aware of any potential threat to stocks. This is then to be elevated to a red status when the service is actually being affected.

- Reserve Fleet

  Service Providers are requested to update the location of their reserve fleet (salt spreaders and snow blowers) on a daily basis or when the situation changes. Temporary movement of fleet or longer term relocations can now be recorded.

5.1.5.7 Email Communications

The WRF1 will automatically generate email alerts when a Service Provider submits a report recording winter service decisions or a Severe Weather Desk has been called or stood down. It is suggested that Service Providers create their own functional email account from where they can manage their stakeholder distribution list.

5.1.5.8 Geographical Information System (GIS) Web Based Mapping

Web based GIS mapping, which does not require additional software, is available from WRF1 and can be accessed from all data entry pages or from the Reports Menu. The map layers show current actions, predominant weather conditions, weather related incidents, gritting routes and business continuity information. Improvements have been made in order to speed up the functionality of the mapping.

5.1.5.9 Training

A user guide is available on line and a detailed training manual in Adobe PDF format may be downloaded from the WRF1 website to further assist training and gives guidance on system changes. However, if further training is required this may be requested via Ray Farlow of Atkins on 0121 483 5402.

5.1.5.10 Further Information

The WRF1 system is user friendly, however if new users require further guidance on the use of this facility or additional user id/passwords are required, please contact: Rachel Walton (Highways Agency), Tel: 0121 678 8538, e-mail: wm_nart@highways.gsi.gov.uk

5.1.6 Strategic Salt Stock Monitoring

The Service Provider must routinely monitor salt stocks during the winter period and report salt stock capability levels as part of the established daily winter service reporting procedures using the on-line electronic reporting system, WRF1. Daily reporting must commence on 1st October and end on 30th April. Full details of the procedures are provided at Annex 5.1.2.

5.1.7 Winter Service Resources

Effective winter service may be achieved through the co-ordination actions of trained and appropriately qualified staff. The Service Provider must ensure that the equipment and depots operate efficiently. The Service Provider must prepare the equipment (including calibration where required) and the depot facilities in advance of the Winter Period, so there is no delay if bad weather occurs earlier than expected, and undertake proper and effective maintenance of all equipment throughout the winter period.

The Highways Agency will make available compounds, vehicles, plant and equipment as appropriate to the form of contractual arrangement and may make available additional reserve resources if the Service Provider requires them due to breakdowns or severe conditions.

The Service Provider will provide other resources including staff and materials as required.
The Severe Weather Plan must detail all resources available for delivery of an effective winter service on the Network and include procedures for mobilising reserve items.

5.1.8 Liaison and Communication Arrangements

5.1.8.1 Liaison

The management of the interface between the trunk road network and other networks is essential to the consistent provision of winter service.

The Service Provider must discuss with adjacent authorities and private network managers (including motorway service areas, airport/ rail roads) to agree interface management arrangements at the onset of each winter season. As part of these discussions the Service Provider must highlight parts of other networks that are important to its operational effectiveness and that of the Highways Agency

Provision of mutual aid and design of winter service treatment routes including cross-boundary arrangements are dealt with in chapter 5.4

Clear lines of communication must be established, contact names and telephone numbers agreed and all documented in the Severe Weather Plan such that communication is possible at all times.

5.1.8.2 Network contact details

Contact details for the principle staff involved in the delivery of the winter service must be provided. This should include out of hours contact details where appropriate. Details of all adjacent Highway Authorities and other service providers must be included as well as emergency services details.

5.1.8.3 Service Provider Communication

The Service Provider must provide and maintain an effective telecommunications system between the Service Manager, the Service Provider's supervisory staff and winter service vehicles during the winter period. Mobile telephones communication must not be relied upon since these can become over loaded particularly during extreme winter weather, or in the event of an incident causing major congestion.

Full details of the communication system for winter service vehicles and the back-up communication system for winter service vehicles must be included in the Severe Weather Plan.

When considering the provision of a dedicated telephone number for inclusion in the Severe Weather Plan, the Service Provider should consider combining this with other requirements such as those in connection with incident management. Substantial operational benefits can be obtained by providing a permanently manned control centre to co-ordinate the Service Provider's work.

5.1.9 Records

A comprehensive set of records must be maintained by the Service Provider in accordance with the Severe Weather Plan. Records are required to defend against liability claims made in respect of winter service and it follows that they need to be high quality.

5.2 Severe Weather Plan

5.2.1 Introduction

The Service Provider must prepare a Severe Weather Plan which must be submitted to the Service Manager on or before 21 August each year. The Service Manager will review and comment on the Severe Weather Plan on or before the 18 September each year.

The Severe Weather Plan template is detailed in Annex 5.2.1 and must be followed. The plan describes the different activities undertaken as part of winter service including, details of procedures, resources and contact information.

5.3 Weather Information

5.3.1 Introduction

The primary requirement of winter service is to provide safe passage for road users by keeping the Network free of ice and snow and open at all times. However the Service Provider must always aim to achieve this with as little impact as possible on the environment. This involves providing the correct level of treatment (spread rates, timings and frequency) at all times and minimising unnecessary treatments. To do this the Service Provider requires a robust information system to provide it with accurate real-time data on both weather forecasts and actual road conditions.

The Highways Agency's Road Weather Information System, RWIS, (see 5.3.3 below) provides a level of service that, when further enhanced by the provision of thermal maps (see 5.3.6) and a regular weather forecasting regime (see 5.3.2), enables the Service Provider to make informed decisions based on forecasts and then to monitor and update them should actual conditions change.

The road weather forecasts described below must be obtained by the Service Provider daily, including weekends and public holidays throughout the Winter Period. The name of the forecasting organisation, the date and the time of issue must be recorded with all forecasts.

5.3.2. Weather Forecasting

5.3.2.1 24 Hour Forecast

A forecast for the following 24 hours should be obtained between 1200 hours and 1600 hours, or at an alternative time if specified in the Service Provider's contract. The text of this forecast should include:

- A general synopsis, with timings, over the following 24 hours
- Minimum air and road surface temperature predictions for agreed climatic/administrative zones and the timing of zero crossing if appropriate
- Relative humidity and dew point, including a warning of any predicted combination of low temperature and low humidity conditions
- The likelihood and timing of any precipitation or deposition on road surfaces
- If snow is forecast, its timing, amount and type and the direction from which the snow will develop, the likelihood of drifting and the height above which accumulation is likely
- Visibility – danger of thick fog (<200 m visibility) or freezing fog formation, the location and timing
- Wind speed and direction; gale warnings and timing
- Confidence level in the forecasts (low, medium or high)

5.3.2.2 2-5 Day Forecast

A 2-5 day forecast should be obtained with the 24 hour forecast. The text of this forecast should include:

- A general synopsis and anticipated trends over the period
- Specific condition reports for day/night of days 2 and 3
- Confidence level in the forecasts (low, medium or high)

5.3.2.3 Site Specific Forecasts

Where information is received from road weather sensors, detailed 24-hour site specific forecasts should be obtained between 1200 hours and 1600 hours, or at an alternative time, where specified in the Service Provider's contract. These forecasts should include:

- Graphical representation, against time, of predicted road surface temperatures and surface condition.
- Textual site specific forecasts, including thermal map type and confidence in the forecast.

5.3.2.4 Evening Update of Forecasts

If minimum overnight road surface temperatures are expected to be below +4°C, an update of the 24-hour forecast and of the site specific forecast, including advice of "no change" if appropriate, must be obtained between 1800 hours and 2200 hours or as otherwise specified in the Service Provider's contract. An update may be appended to the end of a previous forecast.

5.3.2.5 Further Updates of Forecasts

The Service Provider must ensure that the forecasting organisation notifies it immediately, and specifically, of any change in previously forecast conditions. In particular, any change relating to snow, be it an improvement or a worsening of predicted conditions, must be reported immediately and all forecasts updated, including the 2-5 day forecast.

5.3.2.6 Morning Summary

A morning summary should be issued by 0900 hours. The text of this report should include:

- A morning summary of weather over the previous 16 hours (1500 hours to 0900 hours)
- A brief forecast for the following 24 hours, valid until issue of the 24 hour forecast
- Notification of any suspected faults in the road weather information system, if such a system is in operation.

5.3.2.7 24 Hour Consultancy Service

The Service Provider should ensure that the forecasting organisation is available by telephone 24 hours a day, 7 days a week for consultation on the weather conditions and details of forecasts. The Service Provider should ensure that the forecasting organisation provides a response within five minutes of any enquiry from the Service Provider.

5.3.2.8 End of Season Analysis

At the end of each winter season the Service Provider should ensure that the forecasting organisation produces an end-of-season analysis of the accuracy of forecasts based on information contained in the RWIS. For each forecast site this analysis should include:

- A graph of actual versus forecast minimum road surface temperatures
- A pie-chart detailing the frost prediction accuracy by comparing forecast frost against actual frost conditions (i.e. frost/frost, frost/no frost, no frost/frost or no frost/no frost)
- The bias and root mean square error in the forecast of minimum road surface temperature.

The Service Provider should retain copies of the analysis and make them available to the Service Manager if required.

5.3.2.9 Level of Accuracy

The accuracy of road weather forecasts should be no less than 90%. Calculation should be on the basis of the percentage of predictions in the "no frost/no frost" or "frost/frost" categories for the winter nights considered, when the observed minimum road surface temperature at a forecast site is +4°C or below. If an update has been issued before midnight, it should be used in the analysis even if it is less accurate than the original forecast.

5.3.3 Road Weather Information System

The Road Weather Information System (RWIS) which now covers the whole of the trunk road and motorway network obtains information from meteorological outstations. Provision of weather forecasts, the continuous monitoring of actual conditions and determination of winter operations can be provided through accessing the RWIS. The service is procured centrally by the Highways Agency through three separate contracts, namely:

- **The Bureau Service;** a centralised data management service which manages and enables the flow of forecast and roadside weather outstation data between the forecasting organisation and the Service Provider's offices and Regional Control Centre, to allow the remote monitoring of road surface and atmospheric conditions for the detection and prediction of ice formation and other adverse weather conditions;
- **The Operation and Maintenance Service** which maintains and operates the network of outstations and ensures that inspection, calibration, maintenance, repair and modification works are carried out as required, and
- **The Supply and Installation Service** which provides for the supply, installation, testing and commissioning of new outstations which are then integrated into the existing system. This service includes both new outstations and the replacement of old or damaged outstations.

Two standard communication protocols are used by RWIS, namely

- Department for Transport Specification TR2020C (further information available by email from tss_plans_registry@highways.gsi.gov.uk), for the link between the Bureau and the forecast organisation, and
- A modified version of BUFR, an open worldwide meteorological protocol, which allows the transmission of visual images, for the link between the outstations and the Bureau.

These open protocols ensure that ice prediction systems/outstations designed and installed by different companies communicate in a common language with the weather forecasting data collection systems.

In order to ensure that the RWIS is completely effective, roads should be thermally mapped (see 5.3.6) to identify their temperature profiles and any environmental characteristics that could lead to variations in road surface temperature. Thermal mapping in turn will assist in deciding the most appropriate location for outstations and road sensors.

5.3.4 Site Selection of Outstations

The trunk road and motorway network is covered by RWIS outstations, which have been located to best suit the weather domains throughout the trunk road and motorway network. The decision on where to site a new outstation includes all stakeholders in the RWIS as it is dependent on the variability of paved surfaces and elements in both time and space. Before starting on the process of site selection, careful consideration should be given to the use that will be made of the data. Likely applications are:

- Providing information for forecasting and for monitoring the progress of weather changes and comparing actual conditions with those forecast
- Monitoring conditions at sites where road conditions may be significantly different from those on most of the road network or where there is a special need for accurate information on road conditions

For the first application the sites are usually typical of the majority of the road network within that particular weather domain, be well exposed to wind and weather but not on steep slopes. A full set of road surface sensors and meteorological sensors are installed at such sites. Information from these representative sites comprises the necessary input for forecasting road surface conditions.

The second application is, in general, related directly to the needs of the Service Provider. For example, it may be thought desirable to have accurate information on road conditions near a bus station or hospital (even if those areas are neither very well exposed nor likely to be particularly cold), on a bridge that has a thermal response that is very different to the majority of the road network or in a low-lying area into which cold air can drain from the surrounding high ground. Such locations are likely to require only road surface sensors.

5.3.5 Organisational Changes to Maximise the Benefits of RWIS

Installing a RWIS and carrying out thermal mapping will not automatically lead to economies in Winter Service. Consideration also needs to be given to how application of the technology can enhance the efficiency of winter service routes, staffing and shift manning arrangements. For example, a stand-by shift may be replaced by a call-out shift arrangement and inspection patrols reduced or eliminated.

5.3.6 Thermal Mapping

Thermal maps are procured by the Service Manager and are not included in the RWIS contracts. All sections of the trunk road and motorway network have now been thermally mapped but new additions to the Network or changes to pavements following maintenance may need to be mapped/re-mapped. The specification for thermal mapping is set out in Annex 5.3.1.

When using thermal maps it is important to recognise that the road surface temperature varies in both space and time. It is dependent on certain factors such as altitude, topography, road construction and sky-view factor, and on variable factors such as traffic density, and weather conditions. To cover all these variations there are usually three types of base thermal map produced; extreme (clear sky), intermediate (partial cloud) and damped (cloudy).

Thermal maps, which depict the spatial variations in minimum road surface temperature, provide an indication, for the above three weather conditions, of how the minimum road surface temperatures at all mapped points on the road network are related to the minimum road surface temperature at those points where measurements and/or forecasts are available at outstations. Three different versions of the map are usually available each night to assist the decision making process:

- A map showing the minimum temperature based on the forecast for a particular outstation
- A map showing the forecast changes for each hour through the night
- A real-time thermal map giving actual measurements on an hourly basis through the night.

5.4 Winter Service Route Planning

5.4.1 Introduction

The Service Provider must review its designed winter service routes (WSR) annually to ensure that changes in the Network are considered and that WSR are optimised to be as efficient as possible in terms of treatment lengths and time to complete treatment.

The Service Provider should take into account the traffic level on the WSR to avoid, where possible, the peak periods of use and the potential need for different requirements on different lanes of the carriageway. The use of computer software can significantly improve WSR optimisation and allow for adjustments to WSR to be made quickly and easily while maintaining a high level of efficiency. This is particularly effective if short-term changes occur such as temporary road closures or other traffic management.

5.4.2 Liaison with adjacent Highway Authorities and Service Providers

The Service Provider must liaise closely with adjacent Highway Authorities and other service providers when designing WSR to ensure consistency and continuity of winter service operations on all sections of the Network and with adjacent highway networks. The Service Provider must inform and keep informed adjacent Highway Authorities and other service providers of any changes to WSR.

Particular attention should be given to liaison with adjacent Highway Authorities for treating diversionary routes. If the diversionary route is outside of the Service Providers Network then the Service Provider is required to agree the treatment operation with the adjacent authorities.

5.4.3 Mutual Aid Arrangements

Mutual aid can be many different things, from the sharing of resources such as salt, the sharing of facilities that may provide a better coverage of the Network, or the provision of a full winter service to a particular part of another network. For example, there are local roads that Service Providers may treat to ensure their own operational effectiveness such as access routes to depots.

Mutual aid arrangements, including cross boundary agreements, will help to ensure that the winter service provided on the country's road network is consistent and seamless to the road user. The Service Provider must therefore ensure that all such arrangements are documented and disseminated to all operational staff for their action.

Mutual aid arrangements can also be used to provide support to, or obtain support from, other network operators during times of stress, such as during severe weather, to the benefit of the road user. As part of pre-season discussions the provision of support at such times and capabilities of provision should be discussed and contact details agreed.

Whatever mutual aid arrangements have been made, when deciding whether to provide support to others the Service Provider should consider the possible effect on the Network. All requests for support from, or to, other network operators and subsequent decisions, with reasons if necessary, should be documented.

5.4.4 Cross Boundary Agreements

The Service Provider must ensure that the arrangements for winter service at the interface of the Network and other service providers and Highway Authorities networks, are documented in the Severe Weather Plan.

This agreement may include, the location (extent), type (including spread rate) and timing (particularly relevant when considering access to depots) of treatment. Such agreements should help to ensure a consistent service that will not leave potentially important sections of either network isolated.

5.4.5 Liability

The Service Provider must note that where arrangements are made with other service providers or Highway Authorities for winter service operations to be provided by them on the Network, it is the responsibility of the Service Provider to ensure that such service has been carried out. Mutual aid arrangements do not absolve the Service Provider's obligations.

5.4.6 Network Components

The Severe Weather Plan must identify components under 5.4.6.1 to 5.4.6.3 that are within the Network. Components, where treatments to be undertaken under given conditions are different, must be identified. Examples of components that may require different treatments are given below.

- Network carriageway by route/road hierarchy.
- Major structures (by road hierarchy)
- Footpaths by hierarchy (including pedestrian areas)
- Cycle tracks
- Footbridges/underpasses
- Lay-bys
- Special sites or features (e.g. near railways, traffic calming, tunnels; bridges requiring specialised treatment).
- Other miscellaneous sections
- Locations of solid concrete safety barrier

The information provided should also highlight boundary interfaces and the organisation responsible at those locations. See Chapter 5.1.8 for advice on liaison and communication arrangements with these organisations.

5.4.6.1 Snow Gates

Procedures for operating snow gates must be agreed with the police and included in the Severe Weather Plan.

The Service Provider must close and subsequently re-open snow gates only upon receipt of instructions from the Police. Should the Service Provider consider that snow is rendering or has rendered the road unsafe to vehicular traffic, a request should be made that the Police initiate procedures to close the snow gates.

5.4.6.2 Snow Fences

Powers to erect snow fences, and to establish easements, are provided in the Highways Act 1980. Negotiations of terms for the procurement of easements from landowners and tenants should be undertaken by the Service Provider in consultation with the Service Manager. Cases where agreement cannot be reached should be referred to the District Valuer. For guidance on the design and location of snow fences, the Service Provider should refer to the Service Manager.

5.4.6.3 Snow Storage

The Service Provider must identify locations where snow removed from the Network is to be stockpiled, and arrange for provisional approval by the relevant bodies for the use of the locations by 1 August each year, or such other date as agreed with the Service Manager for submission in the Severe Weather Plan.

5.4.7 Winter Service Route Design

5.4.7.1 Introduction

The Service Provider must design all carriageway WSR to ensure that all physical constraints on the Network such as gradients, widths, radii, traffic calming features, operations near railways and the like are identified and taken into account in the design of routes and plans for the deployment of resources.

The Service Provider must allow for variations in anti-icing/de-icing material, application frequency, spread rates (either due to carriageway type or weather conditions), spread patterns, free running and wastage factors. The design must allow for variations in traffic flow and poor weather conditions to ensure that complete coverage of the Network could be achieved within the times stated in the Severe Weather Plan. This must include all carriageway marginal strips adjacent to carriageways, motorway hard shoulders, width variations, bus and other dedicated traffic lanes, footways, cycle tracks, slip lanes to motorway service areas and the interfaces with adjacent highway networks whether they are within, adjacent to or separated from the main carriageway.

The Service Provider should prepare WSR drawings to a scale suitable for clearly detailing the above items. Schedules should also be prepared for each WSR drawing.

The advice and instructions, through WSR drawings and other information, used by operatives must be robust in the event of the documents being required to be used in defence of a third party claim.

5.4.7.2 Carriageways

Designs of WSR for anti-icing/de-icing precautionary treatment, should allow for full coverage of the specified or instructed rate of spread of anti-icing/de-icing materials over the full width of all areas of carriageway. For hard shoulder or carriageway marginal strips anti-icing/de-icing material coverage should be at 50% of the full rate of spread required to meet the requirements as detailed in the Routine & Winter Service Code.. The Service Provider should give consideration to the creation of a simple database of start and finish times to enable reports to be quickly generated and provided as required by the Service Manager.

The Service Provider must design snow clearing WSR for carriageways on the Network taking into account the requirements detailed in the Routine & Winter Service Code

5.4.7.3 Footway, cycleways, pedestrian and equestrian areas

The Service Provider must design WSR for footways, cycleways and other areas used by pedestrians, cyclists and equestrians, in conjunction with local highway authorities.

In order to facilitate integration of service with local highways authorities, the categorisation described in the Roads Liaison Group document ‘Well Maintained Highways – Code of Practice for Highway Maintenance Management’ should be adopted. This categorisation is described in the following table.

Table 5.4.1 Footway Categorisation

Category No	Category Name	Brief Description
1a	Prestige Walking Zone	Very busy areas of towns and cities with high public space and streetscene contribution.
1	Primary Walking Route	Busy urban shopping and business areas, and main pedestrian routes.
2	Secondary Walking Route	Medium usage routes through local areas feeding into primary routes, local shopping centres, etc.
3	Link Footway	Linking local access footways through urban areas and busy rural footways
4	Local Access Footway	Footways associated with low usage, short estate roads to the main routes and cul-de-sacs

Categorisation should be agreed with local highway authorities where the Network adjoins their network. Footway and/or cycleway facilities that are specifically promoted by the Highways Agency or local highway authority should be included within Category 1. Consideration should be given to facilities that, for example, are promoted within route management strategies and Local Transport Plans or have specific signing schemes in place ('specific signing schemes' refers to signed 'routes' rather than the normal signing of facilities dedicated to pedestrians or cyclists). Such routes should only be re-categorised where they serve business, commercial or educational facilities. Promoted routes that are recreational in nature would not normally merit re-categorisation.

It should be noted that footways on trunk roads are generally associated with low usage and will therefore usually fall into Category 4. Category 1, 2 and 3 footways will not be commonplace on the Highways Agency's network.

Where there is a particular identified high risk of accident resulting from the formation of ice, that section of footway should be Category 1. For guidance, situations where an accident is more likely to happen than not would merit re-categorisation. An example of this would be a footway on a steep gradient where walking in icy conditions would not be possible. Footbridges and associated access ramps and walkways should also be reviewed and considered for re-categorisation.

Categorisation of facilities for cyclists and equestrians should be undertaken on the same basis as the defined footway categorisation and, where appropriate, in conjunction with the local highway authority.

Treatment & Snow Clearance

The timing and type of treatment should be coordinated and agreed with local highway authorities to ensure that footways and cycleways are treated consistently along their length.

Such agreement with local highway authorities must be based on the principles contained within the Treatment & Snow Clearance Table 5.4.2 but variation from the defined treatments is acceptable on a local basis. However, where a local authority has chosen not to undertake any treatment at all, it is not acceptable to follow their approach.

Where a footway or cycleway facility is wholly within the Network and there is no interface with the local highway authority network the requirements within Table 5.4.2 below will apply.

Table 5.4.2 Treatment & Snow Clearance Table

Category	Overnight Frost Conditions *overnight forecast temperatures below zero but not extending beyond 8am*	Daytime Frost Conditions *overnight forecast temperatures below zero extending beyond 8am*	Extended Frost Conditions *forecast temperatures remaining below zero throughout daylight hours*	Snow Events
1a	Precautionary treatment		Monitor and further treatment as required	Snow removal must commence when resources come available from carriageway treatments. Endeavours must be made to complete clearance within 12 hours of cessation of snowfall, subject to availability of resources
1	No treatment	Reactive treatment (by 8am of that same day)	Monitor and further treatment as required	Snow removal must commence when resources come available from carriageway treatments. Endeavours must be made to complete clearance within 24 hours of cessation of snowfall, subject to availability of resources
2	No treatment	Reactive treatment (by 8am of that same day)	Monitor and further treatment as required	Snow removal must commence when resources come available from carriageway treatments. Endeavours must be made to complete clearance within 48 hours of cessation of snowfall, subject to availability of resources
3	No treatment	No treatment	Reactive treatment (by noon of that same day)	Snow removal must commence when resources come available from carriageway treatments. Endeavours must be made to complete clearance within 5 days of cessation of snowfall, subject to availability of resources
4	No treatment	No treatment	Reactive treatment not normally undertaken other than in response to specific circumstances	

5.4.8 Traffic Calming Areas

5.4.8.1 Introduction

The advice in this section has been prepared from the findings of an extensive study to identify issues associated with perceived difficulties in carrying out effective winter service operations where traffic-calming measures have been introduced on the trunk road network. The research

project studied experience amongst Service Providers in England and Local Highway Authorities in England and Road Authorities in Scotland. It also reviewed experience in a number of overseas countries.

The research concluded that the range of traffic calming measures adopted is extensive and that most authorities have not experienced significant problems. There have however been difficulties in carrying out effective winter service in certain situations and the Service Provider should be aware of possible measures to assist the delivery of the required level of service.

It should be borne in mind that traffic calming features have been used for a relatively short period of time during which time winter weather conditions have seldom been severe. Caution should therefore continue to be exercised when planning winter service operations in the vicinity of traffic calming features so that they are likely to be adequate in all reasonably foreseeable conditions.

The advice at this stage concentrates on short-term issues and remedies, but also indicates possible options to deal with issues more effectively in the longer-term. The Service Provider is advised to be alert to the effectiveness of its operations and ensure that adequate information and feedback on their experiences is provided to the Service Manager.

5.4.8.2 Traffic Calming Sites

The range of traffic calming measures installed on trunk roads in England to include:

- Speed cushions
- Two-way chicanes
- Central refuges
- Traffic islands
- Road narrowing
- Over-run areas
- Rumble strips and
- Road markings.

With the exception of road marking techniques to influence traffic speeds all the features are likely to involve some level of conflict with the winter service operation. Conflicts may be in terms of some form of step in the carriageway, impacting on ploughing operations, or in terms of deflection or narrowing of the carriageway, which will also complicate ploughing operations.

For example, overrun areas are used to give large vehicles more road width and can have a step height of 15mm with a total height that can be as high as the kerb. The general location is signed as part of the roundabout or horizontal deflection with no specific signing of the overrun area so their presence may not be clear if the feature is buried under snow. Snowplough drivers should be made aware of where overrun areas are installed on a given route. Similarly, anti-icing/de-icing of cycle by-pass lanes located at the nearside of traffic islands can also be a problem.

Despite the apparent conflict between traffic calming features and winter service operations, there have been relatively few reports of damage occurring to either the traffic calming feature or to equipment on snowploughs. In addition, there have been no reports of lack of effectiveness of the winter service treatments. This may be due to limited reporting of experience to date or to the care being exercised by winter service teams.

The Service Provider must be aware of the location of the various traffic calming sites on their sections of the trunk road network. Across the trunk road network as a whole, different types of features may occur singly or in combination at any site. Designs of traffic calming features must be simple and not over elaborate in areas of high snowfall.

The range of types of feature is normally quite variable and care needs to be exercised to ensure that appropriate measures are taken for winter service operation to be effective.

5.4.8.3 Locating Traffic Calming Features

Advance Warning Signs

There are few general requirements or regulations for advance signing of traffic calming features on the highway. The exception is road humps, including speed cushions, which require signing in advance of the first measure but each hump or cushion in a series does not require an individual sign. As rumble strips do not stand out visually from the rest of the road surface no signing is required. Moreover, rumble strips are not a problem if their height complies with Traffic Calming Regulations.

Gateways act as general advance warning for all features.

In the absence of the need for general regulatory signing of traffic calming features, Service Providers may use other forms of marker to assist the vehicle operators in identifying the existence of a feature. It is important however that such markers do not infringe traffic sign regulations and thereby constitute an obstruction within the highway.

It appears that many Service Providers do not feel there is a need for advance marking of traffic calming features because the detailed local knowledge of their vehicle operators ensures that the precise location of the feature is well understood. This approach should be reviewed as it puts pressure on the operatives during what can be difficult conditions.

Vehicle operatives must be able to identify features in all reasonably foreseeable conditions and circumstances. In particular the Service Provider should ensure that:

- Advance warnings signs used to identify existing features meet any regulatory requirements and are clear unambiguous, well referenced, understood by the providers and are clearly represented on route plans.
- Existing arrangements offer an appropriate high level of confidence for precise identification of the features in all conditions.
- Locations and types of newly-installed traffic calming features should be disseminated to winter service operational staff.

(The above criteria should be used to check existing signs at traffic calming sites on the Network).

Physical Warning Systems at the Traffic Calming Feature

There are no requirements or regulations for signing the actual position of traffic calming features on the highway with the exception of providing bollards at islands and refuges.

Warning systems at the traffic calming feature may, in isolation, be of limited value to the spreader driver because or closeness to the feature before being able to take any necessary action. If such markers are provided at each kerbside in addition to advance warning signs, they could serve a useful function in confirming the actual position of the feature when covered by snow. Experience appears to suggest that markers are not always required, but the effectiveness of the arrangements

should be kept under review. Marker posts will almost certainly not be required when an individual calming feature consists solely of markings or rumble strips.

If considered to be useful, marker posts should be of types that are unique and distinguishable from any other form of roadside marker in the area. There is no current requirement for designers to use marker posts at calming features but the Service Provider should:

- Use judgement based on local experience to decide if such markers are necessary at traffic calming features to ensure the winter service operation is carried out satisfactorily
- Ensure that marker posts have reflective faces in accordance with TSRGD and that the marker posts are set back from the carriageway in accordance with the Traffic Signs Manual
- Ensure route consistency in respect of marker post selection and setback from the carriageway.

(The above criteria should be used to check existing marker posts at traffic calming sites on the Network)

Location Sensors Embedded in the Road Surface

There is no evidence that electronic embedded tags are used on the road network in England to assist in locating traffic calming features. Their use would offer benefits over manual location markers, but they are considered to be less flexible, and of less benefit, than GPS systems. If it were decided to fit tags retrospectively, the costs could be quite high and probably unjustifiable.

Global Positioning Systems (GPS)

GPS are developing quite rapidly and being fitted more regularly on Winter Service spreaders to allow the driver to control various spreading parameters. Where GPS equipment is already fitted on vehicles, it is likely to be inexpensive and convenient to fit the supplementary equipment needed to permit global positioning capability so that operators can identify and treat the highway in the vicinity of traffic calming measures.

At present, there is no identified and justified need for GPS systems to be used solely for the location of traffic calming features. In the light of information being collected on future experience it may be advisable that Service Providers investing in winter service vehicles should leave options open for the future enhancement of existing GPS systems.

5.4.8.4 Winter Service Practice in the Vicinity of Traffic Calming Features

For precautionary treatments and/or snow clearance in the vicinity of traffic calming features'. it may be necessary to take one or more of the following actions:

- Lift snowploughs and plough snow around the traffic-calming features;
- Apply heavy salting locally to be carried (by traffic) onto the feature; and/or
- Adjust spread rates or spinners to minimise overspreading.

The second and third points above appear to be contradictory, possibly indicating the diverse nature of situations which may be encountered on the trunk road network and the judgements needed to ensure a safe and accessible Network.

The width of narrowings may influence the procurement of ploughs and the choice of which type of plough to use on a particular route.

5.4.8.5 Monitoring and Reporting

Investigations indicate that Service Providers have not experienced particular difficulties in carrying out pre-salting and snow clearance operations in the vicinity of traffic calming features.

Where the Service Provider does experience difficulty in carrying out Winter Service as a consequence of traffic calming features it should report the circumstances to the Service Manager and make proposals for resolving the matter. When reporting and proposing solutions the following issues need to be considered:

- The nature of the traffic calming feature or features;
- The physical characteristics of the feature(s);
- Any difficulties with locating the features;
- The problems encountered;
- The effectiveness of the attempted treatment(s);
- Any resulting consequences of the difficulties, including implications for highway safety.

When monitoring and reviewing the effectiveness of existing arrangements for carrying out Winter Service in the vicinity of traffic calming features, the Service Provider should:

- Be alert to the increasing use of such measures and the use of multiple and varied calming features in any one location. These conditions may result in the emergence of new challenges which should be dealt with effectively and consistently by operatives.

Report any difficulties encountered during winter service operations to the Service Manager

5.4.8.6 Snow and Traffic Calming Areas

For very heavy accumulations of snow, snowploughing appears to present few difficulties in the presence of traffic calming features, but snow blowers should not be considered other than in the most exceptional circumstances.

Current experience and best practice in carrying out winter service in the vicinity of traffic calming features can be summarised as follows:

1. In view of the claimed lack of difficulty in completing effective winter service operations using traditional techniques, the Service Provider should not necessarily consider changes to its current practice and equipment. It is however important that operations are effective and remain so and consideration should always be given to adopting the most effective alternative techniques where current practices fail to provide the level of service required.

2. The only additional measures reported included the need to adjust speed in some areas and to take special care when ploughing near speed humps and certain types of kerb and ramp.

3. Plough blades should be carefully adjusted for all winter service operations, but especially so when ploughing is likely to take place in the vicinity of traffic calming features that protrude above the normal carriageway level or deviate from the horizontal kerb-line. Sectional spring-loaded plough edges can be used to prevent damage if a plough strikes the traffic calming feature.

5.5 Anti-icing/De-icing Materials

5.5.1 Introduction

To ensure efficient precautionary treatments those anti-icing/de-icing materials should be selected that are appropriate to the requirements of the Network. Although salt, with a nominal 6.3mm grading, is the most common anti-icing/de-icing material used on the motorway and trunk road network, other materials may be used to advantage in specific locations. The Service Provider should consider all relevant materials and select the most appropriate for each part of the Network and for each occasion, taking into account the cost of storing and spreading the material and the environmental impact. The environmental consideration should take account of the effects of both the use and the storage of anti-icing/de-icing materials. Details of the materials selected and justifications should be recorded in the Severe Weather Plan.

Following the introduction of the new pre-wet capable fleet into each area, pre-wet treatment should be used as the Service Providers' default precautionary treatment in the absence of any sound justification for using an alternative. Service Providers must provide all necessary brine production and storage facilities within each depot to serve that areas needs.

Prevention of contamination and degradation of the materials should be considered to ensure that they remain effective and do not create other hazards caused by poor storage or handling. The Service Provider should detail in the Severe Weather Plan the arrangements and regimes that are to be in place to ensure consistency of supply and compliance with good environmental practice. Records of material selection, justification and environmental impact should be retained in accordance with the form of contract.

5.5.2 Dry Salt

5.5.2.1 Introduction

The usual method of preventing the formation of hoar frost and ice on road surfaces, during freezing periods, is to spread granular rock salt before adverse conditions develop. The rock salt utilised for this purpose is usually at or close to its natural moisture content and has a dry appearance, hence the process is sometimes known as 'dry salting'.

Parmenter (1991) reported that, when mined, rock salt has a natural moisture content of about 0.5 per cent. Because rock salt is a hygroscopic material, it absorbs moisture even when stored in covered barns. The salt will absorb moisture up to a content of about four per cent, the usual moisture level at which the salt is spread on the road surface.

The level of moisture can be a critical issue affecting the value of rock salt as an anti-icing agent. This is because dry rock salt, primarily Sodium Chloride (NaCl) has no direct melting action. Melting occurs only after the salt forms a solution by absorbing moisture from the atmosphere or from the road surface to be treated

The maximum size of dry rock salt used on the Network must be 6.3mm to BS 3247:1991

5.5.2.2 Salt storage

The salt should be stored in barns or other designated areas within the Service Manager or Service Provider compounds. All salt which is not stored in barns should be covered in protective sheeting in a manner that avoids the ingress of moisture into the material as far as is practicable. Covered salt gives rise to a number of environmental and cost benefits:

- Reduces product loss from wind and water erosion

- Reduces caking and clumping of stockpiles
- Reduces the volume of runoff that has to be managed
- Improves the water quality of surface runoff

The salt should also be treated with an anti-caking agent before delivery in accordance with the current British Standard. If salt is left exposed to precipitation, anti-caking agents can be washed from the outer layer of the stockpile.

The Service Provider should monitor the moisture content and gradation of particles in the stockpile on a regular basis and record the findings.

The Service Provider should minimise salt handling as each handling can cause salt loss and particle breakdown

Bases for salt storage should be constructed to form a hard, smooth durable surface that is resistant to salt induced spalling. Surfaces formed from materials that are liable to become loose and then mix with the salt should not be used.

As salt is removed from stockpiles a safe slope on the material must be maintained to protect operatives from the risk of collapse of the stockpiles.

Exposed outdoor stockpiles must be formed into the shape of long rectangles

The Service Provider must ensure that salt stockpiles do not become contaminated with foreign matter likely to cause damage to other road users and the winter service vehicles.

Careful consideration should be given to drainage. Water should be prevented from running into stockpiles and any water running from stockpiles should be intercepted and appropriately dealt with to minimise environmental effects. Stockpiles should be located where water cannot rise through the stockpile.

The Service Provider should consider using any recycled wash water, salt laden drainage and other salt containing liquids as part of a pre-wet, or liquid brine treatment regime.

Salt must not be stored within 4.5m of hedges or within the rooting area of trees. It should be stored on impermeable foundations if within 15m of tree rooting areas.

5.5.3 Pre-wetted Salt

5.5.3.1 Introduction

Pre-wetted salt is accomplished by wetting dry salt (at its natural moisture content) at some point between the vehicle hopper and before application to the road surface. The liquid used as a pre-wetting agent can be water or a suitable chemical solution of brine using either Sodium Chloride (NaCl) or Calcium Chloride ($CaCl_2$) . A ratio of 30% pre-wetting agent to 70% dry salt is commonly used.

It is considered that pre-wetted salt enters into solution much more effectively than dry granular salt, thus enabling the anti-icing action to begin more quickly.
One of the main advantages of pre-wetted salt is that, because it has a higher moisture content than naturally occurring rock salt, it sticks to the road more readily, even to a dry road. The anti-icing action is therefore able to begin more quickly and with greater certainty.

Pre-wetting can achieve a 25% reduction in the usage of rock salt.

5.5.3.2 Properties

Pre-wetted salt and brine are effective over a similar temperature range to rock salt but adhere to the road better than dry salt and can be spread more uniformly with less wastage. The anti-icing/de-icing action is more immediate. However brine is more readily dispersed by rain.

5.5.3.3 Storage

The salt component of pre-wetted salt is stored as dry salt with the water or brine being added at the point of application to the road surface. Brine may also be stored as dry salt (although it should be noted that salt of a high purity (>98.5% NACl) is normally used), with a saturator in the compound producing the brine that would then be held in an appropriate tank. Alternatively brine may be obtained and delivered pre-mixed from suppliers and stored in an appropriate tank.

The most commonly used pre-wetting technique requires specialist equipment. A saturator or salt station is required to produce the brine solution (wetting agent), which is simply a semi-automated tank where the brining salt is manually added to the circulated water supply. The concentrated brine then runs into a separate vessel within the tank to be drawn off as required. A weir within the tank collects any undissolved solids and foreign matter, which is then collected and disposed of periodically. A controlled and consistent quality of brine is assured and the whole operation is relatively low cost and maintenance free.

Salting vehicles specifically designed to undertake pre-wetted salting operations are readily obtainable. In addition, hybrid vehicles have been developed that will run both dry and pre-wetted operations. Recent developments have also led to the production of combi-spreaders that spread both dry and pre-wetted salt, in addition to brine only. All vehicles require a hopper for the dry anti-icing agent and integral tanks for the storage of brine. Associated pipe work is also required to pass the brine from its tanks to the spreader. In most cases, existing salting vehicles fitted for traditional dry salting can be retrofitted with brine tanks etc. to enable them to carry out pre-wetted operations.

5.5.4 Alternative Anti-icing/De-Icing Materials

5.5.4.1 Introduction

Alternative de-icing materials are usually more expensive than salt. It is anticipated that any use of an alternative anti-icing/de-icing material will be restricted to isolated, specific circumstances (e.g. structures susceptible to corrosion).

Alternative anti-icing/de-icing materials that may be considered include:

- Potassium Acetate salts in solution
- Urea

Properties of these materials are summarised in the following paragraphs and in Table 5.5.1

5.5.4.2 Potassium Acetate Salts in Solution

This material has a density of approximately 1.25 tonne/m^3 and is sprayed directly onto the road surface. Application of acetate salts in solution may be either by spray bar or by a spinner. The skid resistance of a wet road is not significantly affected by a precautionary treatment.

5.5.4.3 Urea

Urea is a white, crystalline compound with a bulk density of approximately 0.74 tonne/m^3. It is normally supplied as spherical pellets and applied using a purpose built spreading vehicle, with

wetting of the compound taking place immediately prior to its release onto the spinner of the spreading vehicle.

The wetting agent (a mixture of water and anti-freeze), improves spreading uniformity, increases adhesion to the road and resists the material being blown away. It increases the skid resistance of an icy road, but not as dramatically as salt, but the wetting agent can initially have an adverse effect on skid resistance.

Urea should be stored loosely or in 50 kg bags, in a dry, cool building, giving protection from the weather and free from appreciable temperature fluctuations so that condensation from the atmosphere is avoided. Bags, if used, should preferably not be stacked directly upon concrete floors and pallets should be used but should not be stacked more than two high as pressure tends to promote cracking and setting. The building should be well ventilated, to prevent the build up of ammonia fumes, particularly in summer. Forced ventilation may be necessary if all doors and windows are closed. Bulk Urea can also be stored in purpose built plastic lined timber hoppers.

Table 5.5.1 Alternative Anti-icing/De-icing Materials

Anti-icing/ De-icing Material	Approx. cost (see note 1)	Treatment Spread rate	Action/ Effectiveness	Environmental Effects	Health & Safety
Potassium Acetate (Solution)	X12	10-40g/m²	Immediate action Effective for up to 48 hours to - 15ºC in suitable weather conditions	Effectively non-corrosive compared to salt Safe to aquatic life	Gloves and eye Protection Solutions are safe To handle
Urea	X100	20-50g/m²	Requires agitation By traffic Effectiveness: 10% solution to -3ºC 25% solution to approx - -7ºC Little worthwhile effect below -7ºC and ineffective below -11.5ºC Remains effective for up to 12 hours in fair weather but repeat applications need to be more frequent in rain or strong winds	Non-aggressive, but very soluble in water, and may produce ammonia and carbon dioxide. Ammonia is toxic to aquatic life. Ammonia further decomposes to nitrate which, promotes growth of vegetation, and creates an oxygen demand that may cause further harm to life. Urea solutions may be detrimental to steel, plastics and concrete in some circumstances. Vehicles should not be left full of urea for any length of time, and thoroughly washed down after use.	Ventilation, due to ammonia required Safe to handle but the pellets break into powder easily which becomes very slippery due to its high hygroscopic nature. Face masks and eye protection are recommended When heated to melting (i.e. fires) Urea decomposes to form toxic substances. Only trained fire fighters, properly equipped with breathing apparatus should attempt to deal with fires in Urea stores. Local Fire Fighting Services should be informed of Urea stock sites.

5.6 Techniques for Precautionary Treatments

5.6.1 Introduction

The effectiveness of precautionary treatments can be significantly affected by how the treatment is applied. The following advice covers the operational techniques for winter service using the appropriate anti-icing/de-icing material for each part of the Network. Materials other than rock salt are available but their use may require different techniques. The treatments should be applied in accordance with the procedures described in the Severe Weather Plan so as to avoid harm to users and damage to users' vehicles.

Routes used by spreading vehicles should be in accordance with Chapter 5.4. The Service Provider should aim to apply treatment as close, as is practicable, to the forecast time of freezing, in particular avoiding applying treatments during the early evening to protect against a forecast of ice forming in the early hours of the following morning.

5.6.2 Salting

To prevent the formation of ice or frost (or to melt existing snow) the salt must first form a solution. Therefore, after spreading rock salt there is a time lag during which the salt forms a solution and becomes effective. Target spread rates of salt are given in Table 5.6.1.

In conditions where low relative humidity is accompanied by low road surface temperatures, the quantity of dry salt required to melt ice can become excessive. Salt is also relatively slow at entering into solution. Other chemicals, such as Calcium Chloride ($CaCl_2$), dissolve much more readily and therefore become more effective as an anti-icing agent.

To be most effective, salt should be spread before ice forms or snow settles on the road. Anticipating these conditions, and reacting correctly, depends on a mixture of local knowledge and experience, good weather forecasts, and an awareness of the current condition of the road. It is recommended that the Service Provider makes full use of specialised road weather forecasting services and the Road Weather Information System.

The success or otherwise of the operation depends to a large extent on the good judgement of those who decide whether or not to treat. Local geographical idiosyncrasies or other factors may have to be considered in reaching a decision.

Table 5.6.1 Target spread rates for anti-icing/de-icing salt

Location	Spread Rate
Carriageways Frost forecast: Prior to snowfall or rain followed by freezing	 Salt stored under cover 10g/m^2 Salt stored in the open 15-20g/m^2 20g/m^2 to 40g/m^2
Hard shoulder or carriageway marginal strips	50% of selected treatment
Porous surfacing	Plus 25% of selected treatment
Footways, cycle tracks and pedestrian areas	25g/m^2

A good rapport with the weather forecasting organisation is essential if forecasts are to be used to best effect. Various services are now available which provide Winter Service personnel with the kind of forecasts that help to facilitate a good winter service. Chapter 5.3 provides further advice on weather forecasts and the Road Weather Information System.
A decision to treat will depend upon many factors but if road surface temperatures are predicted to fall below plus 1ºC a precautionary treatment should normally take place unless:

- no moisture is on or is expected to be on the road; or
- there is sufficient residual salt on the road to deal with the expected conditions.

However attention is drawn to 5.6.3, below, which highlights the effect of low temperature combined with low humidity conditions.

Road inspections or the Road Weather Information System will help to give an indication of residual levels of anti-icing/de-icing materials and other information about the road surface condition. Elevated sections of roads, including bridges, and sections lying in low ground, or where the topography channels wind borne cold air, are more prone to freezing and may need special attention.

For forecasts of significant accumulations of snow it is essential that sufficient treatment is applied before the snow starts to stick to the road as the treatment will melt the initial snowfall and provide a wet surface beneath subsequent snow making the work of snowploughs much easier.

Effectiveness of Salt after Rain

On a well-drained road during and after rain the thickness of the water film typically varies between 0.08mm and 0.50mm. Once rain has ceased to fall, traffic quickly reduces the water film thickness. Thin films of ice formed by the freezing of water on road surfaces are usually less than 0.25mm thick. Table 5.6.2 gives guidance on the effectiveness of precautionary salt treatments in preventing freezing of the water film and shows the effect of a treatment of 10g/m^2 on the freezing point of the water/salt solution.

Table 5.6.2 Effect of 10g/m^2 Precautionary Treatment on Freezing Point

WATER FILM THICKNESS (mm)	FREEZING POINT
0.25	-2.4 ºC
0.30	-2.0 ºC
0.50	-1.2 ºC

Assuming that the water film thickness will generally not be greater than 0.25mm when precautionary treatment is being considered, a spread rate of 10g/m^2 will thus prevent the formation of ice unless temperatures fall below minus 2.4º C. Should lower temperatures be anticipated however, a rate of spread of 20g/m^2 will prevent freezing down to minus 5º C.

5.6.3. Low Temperature combined with Low Humidity Conditions

5.6.3.1 Introduction

When low temperatures combined with low humidity conditions occur, traditional anti-icing treatments in the form of spreading dry salt can be of limited effectiveness in preventing the formation of ice. Greater diligence and control are therefore often necessary to ensure that the highway is maintained in a safe condition.

Recent research has identified possible measures to maximise the effectiveness of treatments. However, the advice given must be considered within an appropriate comprehensive assessment of conditions and possible treatments.

Low humidity combined with low temperature conditions are most likely to occur in December and January at about the time of the winter solstice. The conditions have, however, been reported

throughout the normal winter operational period and the Service Provider should always be alert to the possibility of them occurring.

It appears that low humidity and low temperature conditions are more likely to occur when the general weather pattern is dominated by cold and relatively dry air masses, usually coming from northerly or easterly directions. These general weather features can be accompanied by winds between 15 and 30 mph. Whilst these features have been observed to be associated with low humidity conditions they are not regarded as the only ones. Therefore, the Service Provider should be alert whatever the general weather patterns.

Slippery road surfaces can also arise due to the formation of hoarfrost. This occurs when air with a dew-point below freezing is brought to saturation by cooling. This leads to the condensation of water vapour directly as ice on the road surface. It appears that in these conditions sufficient water vapour may be available for the formation of hoarfrost, but not necessarily to enable the anti-icing salt to go fully into solution. The phenomenon may also be due to temperature differences between the rock salt and the road surface.

Precise reasons for the formation of ice on a road surface despite the presence of an anti-icing treatment are not necessarily clear, but there are general factors that may often contribute to the situation. These include:

- Dry road surface;
- No precipitation;
- Road surface temperature $\leq 0^{o}C$;
- Road surface temperature ≤ Dew point temperature;
- Relative humidity < 80 per cent;
- Closeness to winter solstice (21st December).

It has also been observed that low traffic flows and high winds may also be significant in reducing the effectiveness of an anti-icing treatment.

The Service Provider must take careful note of the information supplied by its road weather forecasting organisation. These include forecasts of temperature and levels of humidity. Where the forecasts suggest that a combination of low temperature and low humidity are expected, steps must be taken to ensure that an effective treatment regime is adopted which keeps the road free of ice.

5.6.3.2 Rock Salt Moisture Absorption

Below an atmospheric relative humidity level of about 80 per cent, the absorption of moisture by rock salt decreases rapidly and, at low levels of relative humidity, salt particles remain inert and ineffective.

The size of the salt grain can have a significant effect on the rate at which it passes into solution, especially when the available moisture to assist the dissolving process is limited, as in low humidity conditions. This fact can be important on relatively lightly-trafficked roads in that the larger grains may not be broken up by the action of traffic and will therefore take some time to enter into solution. On heavily-trafficked roads the action of tyres should ensure that the larger grains are crushed and spread so that the melting action will be assisted.

Recent studies (Burtwell and Lawrence, 1998; Burtwell, 2000) have shown that, by using a smaller particle size specification for rock salt, the time taken for a solution to form can be reduced. This can be explained by the fact that salt requires a finite amount of water in which to dissolve. The volumetric proportions of a 6.3mm particle would mean that much less moisture would need to be

absorbed to complete the process than for a 10mm-sized particle. It has been illustrated (OECD, 1989) that at –5°C it takes a 2mm grain three times longer to enter solution as a 1mm grain, and at –10°C it takes about five times as long.

Dampening the material with water or other wetting agent prior to spreading can accelerate the process of dissolving salt particles. In recent tests it was found that, by increasing the moisture content from about four per cent to 5.5 per cent, a significantly shorter time was required for a solution to be formed. It appears therefore that increased moisture content assists the dissolving process.

In terms of suitability, it may be prudent to consider the following hierarchy of treatments when low temperature combined with low humidity conditions occurs. It should be noted however that there could be substantial differences in the performance of the various options. The Service Provider should not automatically assume that a treatment lower in the list is an acceptable alternative to one higher in the list (e.g. 6.3mm dry salt is not automatically an alternative for 6.3mm dry salt with any added water). Where doubt exists, the Service Provider should check that the treatment is effective in the prevailing conditions at that time. Treatments in order of expected effectiveness are:

- Full pre-wetted salt using a proprietary pre-wetting system;
- 6.3mm dry salt with added water in the stockpile;
- 6.3mm dry salt with added water in the hopper;
- 6.3mm dry salt

5.6.3.3 Treatment Options

It is essential for the Service Provider to take appropriate steps to ensure that, in all foreseeable situations, there is reasonable certainty that the treatment adopted will be fully effective in preventing ice forming and snow adhering to the road surface.
In order to ensure that a treatment is effective, the anti-icing agent must adhere to the road surface and enter into solution before ice is forecast to form on the road surface. Under low temperature and low humidity conditions, these requirements become increasingly difficult to meet, especially when these conditions are extreme.

If a substantially dry rock salt is spread in these conditions, there is considerable risk that it will not adhere to the road surface or it will not enter into solution. Much of it will probably be blown off the road surface by wind or by vehicle-generated turbulence. It is therefore important to ensure that the anti-icing agent is wetted so that it will adhere to the road surface and be able to enter into solution even in the event that moisture is not available from the road surface or the atmosphere.

The simplest form of wetting of the anti-icing agent could be achieved by simply adding water to the stockpile or vehicle hopper before the spreader begins its salting run. A second stockpile of salt, specifically for use in low humidity conditions, could be located at the depot. This stockpile could be wetted to the desired moisture content as required. The amount of water added should be designed to raise the overall moisture content of the salt load to about six per cent and be well distributed throughout the stockpile or hopper. Before adding water, the Service Provider should know the total weight and moisture content of the salt in the vehicle hopper and then add sufficient water to raise the overall moisture content to the desired level. In broad terms, 10 litres (approx.) of wetting agent should raise the moisture content of one tonne of salt by about one per cent.

Adding water to the hopper of the spreading vehicle is not generally a recommended practice for pre-wetting salt because uniform dispersal within the load is difficult to achieve and ‘clumping’ of the salt particles may occur in the chute feeding the spinner. However, the technique may be considered as a short-term measure where specialist pre-wetting is not available. Ideally, when

faced with low temperature and low humidity conditions, the Service Provider should consider the use of pre-wetted salting treatments.

5.6.3.4 Decision Considerations

It is recognised that a full understanding of low temperature and low humidity weather conditions is still being developed. The Service Provider must nevertheless recognise that these conditions do occur and that they appear to be doing so more frequently. It is therefore essential that the Service Provider develops effective arrangements for treating roads when these conditions occur.

Current knowledge suggests that when temperatures are about or below freezing and humidity is below about 80 per cent the effectiveness of traditional UK anti-icing treatments, such as rock salt, is reduced significantly. In such conditions, the Service Provider should follow the guidance given in this manual.

Careful monitoring of weather forecasts is necessary to establish the likelihood of the conditions developing and also changes in condition that may result in particularly high risks of ice forming. Low temperature and low humidity followed by rain can result in conditions becoming more severe.
The Service Provider should ensure that it has access to equipment that can provide effective treatment in low temperature and low humidity conditions. It may in the simplest form be the ability to wet a load of normal rock salt so that it will adhere to the road and enter into solution. However the weaknesses of this technique have been identified above.
Carrying out effective and timely treatment is necessary to ensure that the likelihood of the anti-icing agent becoming fully effective is maximised.

Monitoring the condition of the Network following treatment should be carried out to confirm that the treatment has been effective. If it has not been fully effective, contingency treatments should be considered which will achieve the required condition. It should be noted that both active and passive road weather sensor systems require the presence of moisture to determine either the concentration of an anti-icing chemical on the road or the freezing point temperature of the solution present on the road sensor.

Liaison with the media and Police should be considered, in order that appropriate warnings to the travelling public can be broadcast in the event of conditions becoming particularly difficult.

5.6.4 Thin Surface Courses

Carriageways with thin surface courses (TSC) require careful consideration. Many of the modern (TSC) materials are characterised by having 'negative texture' whereby a considerable number of voids are present within the finished surface. During the application of anti-icer/de-icer, the residue solution is often trapped in the voids and is withdrawn onto the surface by the action of tyres over the surface. If this occurs regularly on a heavily-trafficked carriageway, a reasonable degree of residual de-icer will remain on the surface of the carriageway to combat the formation of ice. On lightly-trafficked carriageways, however, the de-icer is retained in the voids. These effects are most pronounced on newly laid surfaces when the porosity is highest.

Operational experience has indicated that TSC does not benefit from an increase in dosage above that required for hot rolled asphalt but that the effect of residual salt on the carriageway is reduced, particularly in areas of low traffic, and as such treatment can be required more frequently. Treatment of TSC should be treated with caution; residual material should not be relied upon to provide protection; and if there is any hint of moisture being present, the Service Provider should take a pessimistic view of the forecast.

5.6.5 Porous Asphalt Road Surfaces

5.6.5.1 Introduction

Under certain winter conditions porous asphalt requires more attention than comparable conventional road surfaces. This is due to different characteristics in respect of surface temperature, humidity and the ability to retain salt on the surface. In general, more anti-icer/de-icer is required for treatment of a porous asphalt road surface than for a dense surfacing material.

At high traffic intensities the behaviour of roads surfaced with porous asphalt barely differs from that of dense road surfaces. At low traffic intensities however, the loss of thawing agent into the voids of porous asphalt results in a greater likelihood of freezing in the event of only a small amount of precipitation (condensation, freezing fog) and greater quantities of thawing agent being required to treat heavy precipitation.

Inadequate super elevation or gradient can also be more critical on porous asphalt roads. Precipitation may collect in the voids of the material and be retained at certain locations. The road surface thus remains damp and more likely to freeze in these locations. This action is exacerbated by the differing response of porous asphalt to temperature change. The temperature of a porous asphalt surface falls below freezing point more quickly than a dense road surface and rises above freezing more slowly.

Prompt snowploughing is recommended on porous asphalt road surfaces, but care is required to avoid damaging the surface. Ploughs should be fitted with rubber skirts on the blades.

The following paragraphs contain more detailed information on the performance and treatment of porous asphalt in winter conditions.

5.6.5.2 Treatment of Porous Asphalt Road Surfaces

In winter conditions porous asphalt requires closer monitoring, particularly in the following situations:

- Roads with low traffic flow
- Roads on an incline
- Roads with a limited super elevation
- Hard shoulders
- In the event of changes from cold to warm temperatures
- In the event of snow remaining on the road surface
- In the event of slipperiness caused by condensation
- In the event of slipperiness caused by freezing fog and
- At changeovers from porous asphalt to dense road surfaces.

5.6.5.3 Behaviour of Porous Asphalt with Temperature Change

As temperatures fall, the temperature of porous asphalt road surfaces falls below freezing point an average of half an hour earlier than that of dense road surfaces. As temperatures rise, the temperature of porous asphalt road surfaces rises above freezing point an average of an hour later than that of dense road surfaces. The temperature of porous asphalt road surfaces remains below freezing point about 5% longer than that of dense road surfaces.

In extreme weather conditions (little wind, clear sky), the surface temperature of roads surfaced with porous asphalt is about 1°C lower than that of comparable roads with dense road surfacing materials. The behaviour of porous asphalt as temperature changes can be explained by the relatively high insulation value of the road surface due to the high proportion of voids. As a result, heat is less easily transported from the warmer sub-grade to the surface in the event of frost from above. The voids also provide a greater surface contact area with the cold air. This greater heat/cold exchange also contributes to the lower temperature of porous asphalt in comparison with a dense road surface.

In view of the foregoing temperature characteristics, it is recommended that a thermal mapping survey should be carried out on new porous asphalt surfaces The thermal mapping survey will assist with the re-siting of existing ice detection sensors and indicate the most favourable siting of new sensors to provide an accurate temperature profile of the road. Siting of at least one sensor on all porous asphalt sections is considered to be essential.

5.6.5.4 Behaviour of Porous Asphalt with Humidity

The voids in porous asphalt ensure that precipitation is slowly removed to the shoulder as a result of the super elevation of the road. However, some of the precipitation remains behind in the pores. In summer the remnants quickly evaporate after a wet period, whereas in winter the road dries more slowly. In the case of roads with minimal super elevation in flat areas or that have a large number of traffic lanes, moisture remains on part of the porous asphalt surface for a longer period. As a result of this residual moisture, road surfaces of porous asphalt remain damp. As a consequence roads constructed of porous asphalt will require extra attention when road surface temperatures fall below freezing following a period of precipitation.

If the road surface temperature falls below freezing point after a period of precipitation, roads constructed of porous asphalt will require extra attention on account of the moisture present.

5.6.5.5 Behaviour of Porous Asphalt with Anti-icer/De-icer Treatment

Much of the de-icing agent spread on roads made of porous asphalt disappears into the voids, and only a small proportion remains on the surface. However, because of the 'air pumping action' effect of vehicle tyres, traffic will ensure that the thawing agent in the pores is brought back to the surface of the road.

Consequently some of the anti-icer/de-icer retained within the voids will continue to contribute to the de-icing process. This process will be disrupted if the traffic intensity is low (e.g. at night)and even a small quantity of moisture falling on the road during these conditions (e.g. condensation, freezing fog), can result in porous asphalt road surfaces behaving differently from conventional surfaces. As a result of the extra moisture absorbed by the pores in porous asphalt surfaces, a larger quantity of anti-icer/de-icer is required .

On roads with dense road surfacing, traffic readily leads to horizontal transport of the de-icing agent (i.e. in the direction of the traffic). With porous asphalt this horizontal movement of the de-icing agent is considerably less. As previously stated, traffic also creates a vertical movement of the agent on such roads. This means that the anti-icer/de-icer spread on porous asphalt roads is mixed with the moisture within the pores. In time a balance arises in which the anti-icer/de-icer is distributed as a solution through the pores and over the surface as a whole. This solution is transported vertically and to some extent horizontally by the traffic. Because the moisture in porous asphalt drains away to the shoulder slowly, the anti-icer/de-icer solution remains active for a longer period..

Where a stretch of road with a porous asphalt surface is followed by one of dense road surfacing, extra attention to the initial section of the dense road surfacing is required. Since the horizontal

transport of anti-icer/de-icer on porous asphalt road surfaces is limited compared to that on dense road surfaces, there is a significant reduction in the amount of thawing agent in the initial section of dense road surfacing.

Traffic and dry conditions ensure that the de-icing agent on a road with dense surfacing will gradually disappear even without precipitation. On a road with a porous asphalt surface some of the salt crystallises in the pores under dry conditions. This slow crystallisation ensures good adhesion to the asphalt, and as a result the salt remains active. If treatment takes place several times in a dry period, for example to treat a slippery surface as a result of freezing fog or condensation, without the de-icing agent being removed to the shoulder by traffic action, a salt buffer will be formed in the pores of porous asphalt. If, following a dry period, precipitation occurs when the road surface temperature is below freezing point, the salt buffer which has collected in porous asphalt becomes active again under the influence of the traffic.

5.6.6 Freezing Rain

5.6.6.1 Introduction

The prediction of freezing rain is difficult and the action necessary to deal with it is problematic but Service Providers must consider and plan actions to be taken when such conditions occur. All details of actions intended for dealing with freezing rain must be documented in the Severe Weather Plan.

Considering the limits in the effectiveness of treatments in dealing with freezing rain it is essential that all practical measures are implemented to provide warning to road users of the hazardous conditions.

Measures for dealing with freezing rain fall into three main areas: advance planning, operational arrangements and hazard mitigation.

5.6.6.2 Advance Planning

Advance planning includes consideration of the potential impact of freezing rain and development of contingency arrangements to mitigate the effects. These contingency arrangements should be detailed in the Severe Weather Plan. Other aspects of advance planning include training and exercises. Specific measures that should be considered include:

1. Prior to the commencement of the winter season, agreement should be reached with the police and the Regional Control Centre (RCCs) on procedures for dealing with occurrences of freezing rain and any incidents that may occur during or following such conditions.

2. Outline operational arrangements should be developed and documented within the Severe Weather Plan. Although the adverse effects of freezing rain can impact across any part of the network particular consideration should be given to those parts where the impact may be more significant such as on gradients or difficult alignments.

5.6.6.3 Operational Arrangements

Operational arrangements should include details of treatment regimes. In general freezing rain should be treated in a similar manner to snow, i.e. treatment in advance of and during the event and then treatment following as required.

Specific measures that should be considered by the Service Provider include:

1. If the condition of freezing rain is anticipated contact with the police, RCC, adjoining service providers and local authorities is to be made to inform them of the proposed action.

2. Prior to the arrival of the freezing rain a pre-treatment is to be made in the same manner as would be made prior to snow falling.

3. Constant monitoring of the situation is to be made and an additional treatment is to be carried out immediately the rain commences and continued until such time that the rain has ceased or the temperature of the road has risen above freezing

4. Freezing rain usually occurs along the line of an incoming warm front. If possible, to ensure maximum effectiveness of the salt, the advance treatment should be made in the same direction and immediately in advance of the weather front. Use should be made of weather radar where available to help determine the time of treatment. Consideration should be given to positioning vehicles on the point of the route where the weather front will first hit in order that timely treatments can be undertaken

5. Some salt will inevitably be lost during and following treatment and therefore careful consideration needs to be given to the requirement for continued successive treatments.

5.6.6.4 Hazard Mitigation

The nature of freezing rain means that treatments will have virtually no effect initially and ice will form on the carriageway. Mitigation of the hazard is therefore a significant aspect of the actions taken in response to freezing rain. The main action is to inform road users of the hazard but more proactive measures might be required. For example consideration should be given to closing the road as the rain arrives and holding the traffic (rather than diverting) until such times as it deemed safe to proceed. Such considerations will need to be made on a local basis taking into account local circumstances.

Specific measures that should be considered by the Service Provider include:

- Where available fixed or mobile Variable Message Signs should be used to warn road users of the hazard. The existing established procedures for requesting VMS settings to be made should be followed well in advance. The following legend is currently the most appropriate to use – 'SKID RISK SLOW DOWN'
- National Incident Liaison Officer (NILO) and/or the Highways Agency Press Officer should be contacted in order that the local media can be advised as necessary
- Where available use of variable mandatory speed limits should be considered. This will require arrangements and protocols to be established with the appropriate Police Control office or RCC as part of the advance planning procedures.
- Consideration should be given to the use of rolling blocks and convoy arrangements to either hold or slow traffic down both just prior and during the event. This will require arrangements and protocols to be established with the appropriate police authorities or RCC as part of the advance planning procedures.

5.7 Techniques for Treatment of Snow and Ice

5.7.1. Introduction

The effectiveness of treatments of snow and ice on the paved areas can be significantly affected by the method of application of the treatment. The following advice covers the operational techniques for providing that part of the winter service associated with the removal of snow and ice from paved areas. The techniques include ploughing, blowing, the use of snow fences and snow gates together with changes to the methods of application of anti-icing/de-icing materials when snow or ice is already present on the paved area.

During snow clearance operations, any build-up of snow across rail, bridges, gateways and along fences should be promptly removed and measures taken to avoid further build up. Throughout any operation to remove snow and ice, periodic situation reports should be provided for the Service Manager and road users.

5.7.2 Safety of Operatives and Other Road Users

Winter Service operatives should wear high visibility clothing incorporating retro-reflective markings at all times when out of a vehicle.

U-turns on APTRs must only be carried out when there is no risk to spreading or snowploughing vehicle drivers or to other road users and where it is legal to do so.

5.7.3 Treatment of Settled Snow/Ice

The density of fresh untrafficked snow is about one-tenth of that of ice and the action of traffic assists in the process of melting and dispersal. Approximately 6g/m2 of salt is required for 10mm of fresh snow for each degree Celsius that the air temperature is below freezing point. (N.B. The temperature is normally higher than minus 3^0 C when falls of snow of 10mm or more occur).

If ice has formed salt should be spread at up to 40g/m^2, depending on the amount of ice present and the temperature, to ensure a rapid melt. Particular attention should be paid to lengths of road that are known to be susceptible to 'run-off' water from verges or central reserves. Although the road itself may be dry, accumulations of snow may melt, run onto the road and then re-freeze.

Snow ploughs with soft edges can plough to 0mm although there is a risk of possible damage to the carriageway surface and roadside furniture. Each pass of the plough should be supplemented by salt spread at 20g/m^2 to prevent the compaction of any remaining snow and to aid dispersal by traffic and subsequent ploughing. The Service Provider should commence snow ploughing operations early enough to ensure that snow accumulations do not exceed 10mm in any lane.

It is important to continually monitor the air temperature during clearing and, as the temperature drops, spread rates should be increased, up to 40g/m^2 if necessary. Although current vehicle mounted infrared thermometers offer reasonably high accuracy levels Road Weather Information Systems or thermometers at suitable open sites in compounds, or similar systems are generally preferred.
Even light snowfalls may call for ploughing where local drifting has occurred, or where snow has not been dispersed by traffic. This may occur where the traffic is reluctant to use lanes 2 or 3, or at night when traffic flows are light. During prolonged falls of snow, ploughing should be continuous to prevent build-up and should be supplemented by simultaneous de-icing at a rate of between 20g/m^2 and 40g/m^2.

If snow depths reach 120mm, or when tackling drifts, or when working on gradients, it may be preferable to plough without spreading, since the weight of the treatment load will aid vehicle

traction. When conditions permit, spreading should be resumed. Use of a snow blower may also be considered for the removal of deep snow.

Ploughing or snowblowing is not practical in built up areas. Repeated applications of de-icer can remove heavy accumulations, but this type of treatment is not recommended as it is likely to provide an unacceptable surface for traffic. In such situations, consideration should be given to the use of a snow blower with the snow being directed into an accompanying lorry, followed as soon as possible by salt spreading at 20g/$m^{2.}$

The formation of hard packed snow and ice should be a rare occurrence if the performance requirements are achieved. If it does occur, provided it is no more than 20mm thick and the air temperature is above minus 5^0C, removal is possible by using successive treatments of salt at rates of spread between 20g/m2and 40g/m2.

Great care must be taken as the use of de-icing agents on snow or ice can produce an uneven and slippery surface. If there is any danger that the surface will become unacceptably slippery as a result of using de-icing agents, then the addition of abrasives should be considered. Application of the initial treatment technique should be resumed as soon as possible since abrasives contribute little to the removal of snow/ice and may block drains and gullies upon thawing. Abrasives should not be used on structures where there is any danger of blockage to drains. The principal treatments for settled snow/ice are summarised in Table 5.7.1.

Table 5.7.1 Principal Treatments of Settled Snow/Ice

ROAD SURFACE CONDITION	TREATMENT	
	SALT SPREAD	PLOUGHING
Ice formed	20-40g/m^2 for rapid melting	Not possible
Moderate snow	20g/m^2 to supplement ploughing, up to 40g/m^2 if temperatures are falling	Required
Prolonged snowfall	20-40g/m^2 to supplement ploughing	Continuous (without salting if necessary to aid traction).
Hard packed snow/ice	Successive treatments at 20-40g/m^2 (supplemented by abrasives if necessary)	Not possible

5.7.4 Principal Treatments of Settled Snow/Ice

5.7.4.1 Treatment in Sustained Low Temperatures

For each degree drop below minus 5 ^{o}C, the amount of salt required to maintain the equivalent de-icing effect increases by about 14g/m2. However where traffic is reasonably heavy, little or no increase is necessary until sustained temperatures fall below minus 10 ^{o}C. When sustained temperatures do fall below minus 10 ^{o}C, one method that has proved to be effective is the addition of calcium chloride mixed with 4 parts of salt. It should be noted however that calcium chloride is expensive and difficult to store as it absorbs moisture freely.

5.7.4.2 Spreading Techniques

To be effective, anti-icing/de-icing agents should be spread evenly and at rates that suit the prevailing or expected conditions. Care should be taken to ensure that spread widths are neither too wide nor too narrow. The treatment should be carried out using automatic machines, the controls of which should be calibrated and clearly marked for distinct rates of spread, up to a maximum of 40g/m^2. Higher spread rates are unnecessary, wasteful and environmentally harmful and should be avoided.

Cross-winds can affect the distance over which treatment is spread and to compensate it may be necessary to spread from a lane upwind (if appropriate) from that normally chosen. In exceptionally strong winds it may be necessary to undertake a second treatment run with the spreader set asymmetrically into the wind.

Due consideration should be given to traffic conditions and the timing of winter service operations. Wherever possible without detriment to the effectiveness of treatment, precautionary treatment should be undertaken in off-peak periods when disruption to traffic and to proper distribution of the anti-icing/de-icing agents will be minimised. If precautionary treatment in heavy traffic is unavoidable it may be necessary to seek assistance from the police, Traffic Officer Service and RCC (including motorway matrix signals and variable message signs) or to consider treatment in two runs (to ensure proper distribution of the anti-icing/de-icing agents).

Care should be taken at road works so that, in addition to areas currently being trafficked, all other areas likely to be opened to traffic are treated. Traffic management equipment, including cones and cylinders, may disrupt distribution of anti-icing/de-icing agents. Contra-flow systems should be treated in both directions.

Treatment of any special features should be identified in the Severe Weather Plan and procedures instigated to ensure compliance with agreed methods of treatment.

5.7.4.3 Snowploughing

The technique used for multi-lane carriageways should be '**clearance by lane**'.

Due to differences in local weather conditions, snow depth, snow wetness and road topography, it is difficult to be precise about the order of lane clearance. Also, local traffic densities and movements vary from day to day and even throughout a day, and may affect lane clearance priorities. In prolonged, heavy snowfall the priority will be to maintain lanes open in accordance with the requirements of the Routine & Winter Service Code. In the majority of cases this will be the more heavily trafficked left hand lane (lane 1) and the first operation will be to plough snow from lane 1 to the hard shoulder, with clearance of other lanes continuing as conditions improve.

An alternative technique for a 3 lane carriageway with hard shoulders, particularly suited to echelon ploughing (2 or more vehicles moving in the same direction, one behind the other, in different lanes), is clearance in the following sequence:

- First: plough lane 2 snow to lane 1
- Second: plough lane 1 to hard shoulder
- Third: plough lane 3 snow to central reserve
- Fourth: plough hard shoulder snow to verge.

More than 2 lanes ploughed onto the central reserve could be hazardous to traffic by inviting drifting and melt water problems later. When clearing 4 or more lane carriageways consideration

should be given to abandoning the outermost lane(s) rather than creating problems of excess snow on the central reserve.

Irregular windrows caused by ploughing passes, especially those that weave from one lane to another, are dangerous, as they may tempt drivers to overtake by squeezing into the partly cleared lane. Lanes should be completely cleared, and the windrows of snow remaining should form a smooth and continuous line without sudden encroachments into the cleared path. On motorways, windrows can be left on hard shoulders, but there should be intermittent clearings to provide refuge for broken down or abandoned vehicles, and these should be cleared as soon as lanes 1, 2, and 3 are cleared and should not be left indefinitely.

Under no circumstances should windrows be created across off and on slip roads where they diverge/converge with the main carriageway

Speeds of ploughing vehicles should be regulated, particularly at features such as underbridges, where snow could be thrown over the bridge parapet, and adjacent to the central reserve, where snow could be pushed into the opposing carriageway.

The objective is to clear all lanes and hard shoulders as soon as conditions permit. Clearance work should therefore proceed continuously, since a pause during a snowfall could lead to a build-up, which would take a disproportionately long time to clear. Packed snow, glazed by the wind, can be particularly difficult to remove.

Where clearing single carriageway roads, particularly those which have more than two lanes, snow clearing operations should be carried out so as to avoid any build up of snow in the centre of the road.

When ploughing, motorway warning signals can be displayed, so RCC co-operation is essential. It is not always possible to keep these signals free of snow, but every effort should be made to advise motorists of the snowploughing vehicles ahead.

Special consideration needs to be given to ploughing in areas of contra-flow or other temporary traffic management where normal techniques and equipment may not be suitable.

Snowplough heights

The ploughs provided by the Highways Agency are designed to operate at zero height setting. The Service Provider must ensure that plough heights are set in accordance with the manufacturers recommendations.

Care must be taken to avoid damage to road surfaces, road studs, roadside furniture and structures. At road works, traffic management equipment must not be disrupted. An accumulation of ploughed snow creating a ramp adjacent to safety barriers should be avoided.

5.7.4.4 Snow Blowing

Heavy snowfall, drifting and ploughing operations may result in a build up of snow in the carriageway and hard shoulders. Snow blowers are particularly suited to the clearance of blockages and to the removal of accumulations from the hard shoulder and carriageway where snow may be safely directed onto the verge (or possibly a wide central reservation).

5.7.5 Snow Clearance Adjacent to Solid Vertical Barriers

5.7.5.1 Introduction

The presence of solid vertical barriers (SVBs) can present operational difficulties to snow ploughing operations which will potentially result in snow being stacked on lanes adjacent to them. The following advice on snow clearance techniques to facilitate removal of stacked snow at the earliest opportunity should be used by Service Providers to produce their own strategy for dealing with snow clearance adjacent to SVBs on their Network.

5.7.5.2 Guidance

The Service Provider should consider whether any lanes may need to be abandoned during heavy snow fall due to the build-up of snow when ploughing/clearing adjacent to SVBs.

When conditions dictate it is recognised that it may be necessary to plough snow from lane 2 to the right and sacrifice one or more running lanes to stack snow whilst keeping the maximum number of lanes available to traffic and maintaining access and egress. The Routine & Winter Service Code gives guidance on the number of lanes that should be free from ice and free from snow, as far as is reasonably practicable, during snow fall for each route classification. This information should, where appropriate, be used to assist in developing a clearance strategy.

Suitable advance warnings must be posted to inform motorists if lanes are not available for use. Variable Message Signs or Mobile Variable Message Signs should be utilised.

Care should be taken when considering stockpiling snow adjacent to SVBs as it may create a hazard from which vehicles could cross the SVB. There is also the risk of melt water running across the carriageway with the possibility of it re-freezing.

Following normal snow clearing efforts carried out during snow fall, echelon ploughing to the left whilst spreading salt is an option to clear snow from those lanes sacrificed at cessation of snowfall providing sufficient resources can be made available. This will provide, when combined with a rolling road block, a relatively rapid method of removing the stored snow. Service Providers should consider the training of operatives in echelon ploughing.

A phased approach may be required for 4 or more lane carriageways. Resources may need to be diverted from other areas of the Network where clearance work is complete or considered a lower priority in order to undertake such echelon ploughing.

Consideration should be given to creating a clearance ‘team’ which would clear each section of carriageway with SVBs in turn (although it is recognised that this will not be practical for every area).

Assistance must be sought from Traffic Officers or the Police to provide a rolling block when clearing snow from lanes which have been abandoned during heavy snow fall.

Consideration should be given to using either permanent Variable Message Signs (VMS) if available or to site mobile VMS in advance of the clearance operation.

In many cases the hard shoulder will need to be cleared more than once to allow for snow being cleared from the offside lanes.

Bulk clearance for example by a snow blower may be required where there are SVBs to the nearside and offside or when there is a large amount of snow to remove.

5.7.5.3 Schedule and Clearance Plans for Solid Vertical Barriers

Service Providers must produce a schedule identifying the locations of SVBs on their network. The schedule must be included in the Severe Weather Plan, and should include the following details:

- a network map with each SVB location highlighted
- details of the location in relation to marker posts for motorways or relevant landmarks on an APTR
- the cross sectional position of the barrier (e.g. verge or central reserve)
- the set back of the barrier from the adjacent running lane
- construction of the adjacent verge (grass, hardened, filter drain, v-channel etc)
- number of running lanes
- details of the hard shoulder (e.g. width and construction)
- presence of slip roads diverging or merging
- presence of large areas of hatching, e.g. at diverge or merge tapers
- list of resources required for echelon ploughing including any plant required for bulk clearance
- mobile VMS available for use or locations of permanent VMS
- additional non-dedicated vehicles required to assist with clearance
- details of assistance required from outside parties such as Traffic Officer Service (TOS), Police, RCC etc

Service Providers must produce a clearance plan including a route drawing for each discreet area of SVB. These should be produced in a similar way to a gritting route plan and must be incorporated into the Service Provider's Severe Weather Plan. Each clearance plan, which may be included as part of area route plans, will include specific details for that location abstracted from the schedule along with:

- the techniques to be employed throughout a snow event on that length of road
- details of any lanes that may be abandoned during heavy snow fall
- the optimum time of day for final clearance after the cessation of snow fall (When deciding this time the guidance contained in R&WSC, if appropriate, for the route classification must be taken into consideration along with the traffic flows for that location)
- plant and personnel to be identified for both ploughing and clearance
- locations where additional resources will be sourced
- identify the role of each vehicle in the procession for echelon ploughing (plough only or plough & spreader etc)
- practicalities of having a clearance team for the area
- rendezvous points to assemble in readiness for echelon ploughing
- change over points for continuity during snow clearance
- turn around points
- salt stores for re-loading
- additional hazards for example; road over rail, road over road, SVB to nearside as well as offside, lane gain or lane drop

If standard plans are to be utilised then this must be stated.

Annex 5.1.1 Traffic Officer Service Winter and Severe Weather Briefing

Service Providers are required to hold winter and severe weather briefing sessions with the Traffic Officer and RCC supervisors. The content of the sessions should identify key aspects of the Severe Weather Plan and include:

- Extent of their network, staff involved and their various roles
- Winter Service treatment routes
- Snow ploughing techniques and capability
- The purpose of pre treatments and timing of treatments
- Introduction to weather conditions experienced including severe weather events
- Operational considerations for severe weather events
- Preparations – snow desk exercises, winter service vehicle maintenance, salt stocks, driver training, additional resources
- Procedures – process of obtaining a forecast, difference in detailed local and national advisory forecasts, considerations made, options for decisions on treatments, RWIS.
- Information available to winter service decision makers– weather forecast provider, weather stations
- Reporting
- How Traffic Officers can assist – in line with Traffic Officer Briefing Note 47

It is expected that each briefing will take no longer than 1 to 1.5 hours. To assist Service Providers a PowerPoint presentation briefing template is available from the Service Manager.

An attendance register for completion by all attendees at briefings is included below (Completed register to be forwarded to David O'Connor (David.OConnor@highways.gsi.gov.uk), 2/10 Temple Quay House, 2 The Square, Temple Quay, Bristol, BS1 6HA).

Register of Traffic Officer and Control Centre Staff Briefings			
Date of Briefing:			
Briefing Carried Out By:			
Name	Signature	Outstation/RCC	Network Area

Service Providers may wish to produce a small format (A5) booklet or audio CD to accompany their briefings. This should contain the key points contained in the briefing. It should be possible for the Traffic Officers to keep in their vehicles to allow easy reference.

Annex 5.1.2 Salt Stock Level Monitoring Procedures

1 Introduction

The Highways Agency require the salt stock level monitoring and reporting system to be updated on a daily basis on it's WRF1 reporting system throughout the winter season, commencing on 1 October and terminating on 30 April.

The object of the reporting system is to provide strategic monitoring of salt stock levels and to provide an early warning system to allow critical stock levels to be identified.

2 Capability Assessment

The methodology for the monitoring is based on an assessment of capability. The methodology for calculating capability is not intended to provide an indicative or typical treatment regime but simply provides a common basis on which capability information can be calculated and reported.

Capability is expressed in days and is: the number of days of continuous treatment across all routes, assuming six treatments per day at 20 g/m^2, and also assuming no re-supply. It is not suggested that this is a typical or common treatment regime but it does provide a worst case scenario against which a standard capability measurement can be derived. All capability calculations should be based on salt stocks dedicated to Highways Agency use. This will enable a national overview of stock levels to be taken as well as allowing area performance/DBFO teams the ability to identify, at an early stage, any issues which may affect service delivery

The **minimum capability** is the capability level, in days, assuming all salt storage facilities are at the minimum contractual stock levels.

The **maximum capability** is the capability level, in days, assuming all dedicated salt storage facilities are full to capacity.

The **actual capability** is the capability level, in days, based on the actual stock level held at that time.

The **reporting threshold** is the capability level at which point salt supplies could be considered to be critical. This level is defined by individual Service Providers. The level is not prescribed as it is the responsibility of individual Service Providers to assess local circumstances in defining an appropriate threshold. Climatic conditions, availability of haulage services, established mutual aid arrangements, and the proximity of the source of supply are all key considerations in defining appropriate threshold levels. Consideration also needs to be given to historical usage levels and existing re-supply arrangements in setting an appropriate threshold . It should be noted that this threshold capability level is for strategic reporting purposes only and is likely be different from stock level thresholds used for initiating re-supply.

The reporting threshold is likely to vary during the season and therefore the reporting threshold profile should be defined. Lower reporting threshold levels are likely to be applicable during the very early part of the season and then also towards the end of the season. The threshold level may also need to be increased to take into account potential supply difficulties that may be encountered during the Christmas and New Year holiday period.

The threshold profile should be reviewed on a regular basis and, if necessary, should be adjusted.

3 Advice on Assessment of Salt Stock 'Capability' Levels

In general, a risk based approach should be taken when assessing capability levels and the following factors should be considered.

3.1 Climate

The climatic conditions within the Area need to be considered, particularly the severity of weather events and the likely number of continuous days treatment that may be required should be taken into account. For example, considering this factor on its own, an area in the South West such as Area 1 will require a lower reporting threshold than an area in the Midlands such as Area 11.

3.2 Time of Year

The time of year has a significant bearing on capability levels and a lower threshold may be appropriate in the low risk winter periods (November and March). Service Providers may want to reduce stock holdings towards the end of the season to avoid carrying stock during the summer months. However, care should be taken to ensure that the reduction in stock levels does not result in a reporting threshold that is not appropriate in the later winter months.

In addition to consideration of the winter risk periods, the Christmas and New Year break also needs to be taken into account as difficulties replenishing stock during this period may be encountered.

3.3 Proximity of Supply

The proximity of point of supply for salt, i.e. Winsford in Cheshire and Boulby in Redcar and Cleveland, is a significant factor when considering reporting thresholds. Clearly the nearer to the point of supply the lower the risk of securing re-supply and therefore the reporting threshold can be lower than in an area that is more distant from the point of supply. For example, considering this factor alone and assuming salt is procured from the local supplier, Areas 10 and 14 would have a lower reporting threshold than Areas 1 or 4.

3.4 Availability of Haulage Facilities

The ability of the Service Provider to provide his own haulage for salt can be taken into account when assessing reporting thresholds. However, the availability of vehicles, and drivers, may be limited during periods of severe weather and this will need to be considered.

3.5 Mutual Aid Arrangements

Existing arrangements with other organisations such as adjacent Service Providers and local authorities can be considered when assessing the reporting threshold. It should be noted however that these arrangements might not be very effective during times of prolonged severe weather as all organisation may be suffering from similar high demand and re-supply problems.

3.6 Stock Monitoring and Re-supply Arrangements

The contractual arrangements the Service Provider has in place with his salt supplier can be taken into account when considering the reporting threshold. For example, a supply contract which includes guarantees and associated payment mechanisms offers a lower risk to the Service Provider and a lower threshold could therefore be set In addition, the use of more sophisticated and robust monitoring procedures as part of a supply management system may also decrease the risk of supply problems.

3.7 Other Considerations and Further Advice

There are other less significant factors that may be considered but the key factors remain the climatic conditions and the proximity of point of supply. Care should be taken not to include demand (salt usage) and ‘reserves’ as these are already taken into account in the capability calculation.

When considering reporting threshold the existing contractual requirements for stock levels may be taken into account although the reporting threshold may be higher or lower than the contracted minimum capability

Further advice is available from the Winter Service Delivery Team in the form of a Salt Capability Spreadsheet (Microsoft Excel spreadsheet) and Explanatory Notes (Microsoft PowerPoint slide show)

Annex 5.2.1 Severe Weather Plan Template

The 2009/2010 Severe Weather Plan Template replaces the 2008/09 Severe Weather Plan Template and should be used by Service Providers to update their individual Severe Weather Plans. The following changes have been made to the template. A summary of the changes that have been incorporated into the 2009/10 Severe Weather Plan template are listed below:

1. The title of the template has been amended to read Severe Weather Plan 2009/10

   Information and Purpose – The definition under 'Quality plan' has been amended.

2. The following change has been made to Section 1 – Scope:

   - 1.6.4 Local Problems Areas – additional requirement to include known low humidity/low temperature areas.

3. Various changes have been made to Section 2 – General. These include:

   - 2.1.2.1 Process – additional wording 'for both winter and severe weather conditions'
   - 2.1.2.4 –Guidance section moved from 2.1.2.5
   - Local Problem Areas Requiring Special Consideration – Title and section number changed to 2.1.3 – Mitigation Measures for Local Problem Areas
   - 2.1.3 to 2.1.14 sections renumbered
   - 2.1.7.6 – Winter Service and Severe Weather Briefings for Traffic Officer Service – additional wording added to last bullet point, 'and instances of ice on the network'
   - 2.1.14 Winter Service and Severe Weather Timetable – Key dates have been updated and additional monthly reporting requirement has been added.

4. Various changes have been made to Section 3 – Winter. These include:

   - A new sub section has been added to the Resources 3.1.1.1 Special Considerations – reference 3.1.1.7 changed to 3.1.2.7
   - 3.1.2.5 Low Humidity – Note added regarding issue of further guidance
   - 3.1.2.6 Freezing Rain - Note added regarding issue of further guidance
   - 3.1.2.7 – Sustained Low Temperatures – section re- worded
   - 3.3.2.4 Supply Arrangements – Additional requirement to document secondary supplier backed up with evidence for choice.
   - 3.3.2.6 Monitoring and Reporting – Additional paragraph added to highlight forthcoming changes to AMM 76/06.

THIS PAGE TO BE REMOVED FROM FINAL COMPILED DOCUMENT
Notes for compiler:

This document is a template against which individual Service Providers can base their own individual Severe Weather plans.

Instructions and guidance are shown in italics e.g. *Service Provider to include details of …..*

Square brackets denote a requirement for area/route specific text e.g. Details of the [AreaNo/Route DBFO] network are…..

Any of the text, and other content, within this document template can be modified to make applicable to local circumstances however, all of the text in red should be removed, completed, replaced or amended as appropriate.

As the Severe Weather plans will be public documents it is recommended that, to ensure consistency between documents, the basic style and formatting of the template should not be altered.

Tables should be completed as appropriate or replaced with the Service Providers own tables. Where the Service Provider's own tables are used they should include, as a minimum, the information detailed within the prescribed tables.

The standard forms included at Appendix 11 are primarily for notification to the Highways Agency and therefore, to allow for easy assimilation of information by the Highways Agency, the format of these forms should not be changed

[SERVICE PROVIDER]

[AREA OF RESPONSIBILITY]
SEVERE WEATHER PLAN
(2009/2010)

Contents

INTRODUCTION AND PURPOSE

In conjunction with the Network Management Manual, this severe weather plan describes the policy, objectives, procedures and operational arrangements for the delivery of winter service and details the alert procedures and actions in the event of severe weather on the [Area No / Route DBFO] network.

The document serves a number of more specific purposes:

Policy Document

The severe weather plan sets out the Highways Agency's policy and objectives in the context of local service delivery.

Contract Document

The severe weather plan outlines the key contractual responsibilities of the Highways Agency and their Service Provider/s including the monitoring and reporting of salt stock levels.

Quality Plan

The severe weather plan forms part of Service Provider's quality or business management system.

Contingency Plan

The severe weather plan is linked with the Highways Agency's wider contingency arrangements.

Operations Manual

The severe weather plan describes the processes, procedures and operational arrangements for those responsible for delivering winter services and details the alert procedures and actions in the event of severe weather.

Reference Document

The severe weather plan is a comprehensive reference document.

DOCUMENT CONTROL AND DISTRIBUTION

Document Owner

Document Owner	[Name/Title]

The owner is responsible for maintenance, upkeep and amendment.

Document Control

Document Issue and Revision Record				
Issue	Revision	Date	Issue/Revision Description	Approved

Distribution

Document Distribution List		
Copy Number	Name	Organisation

The distribution list should include: relevant Service Provider staff, TMC and sub-contractor staff, Highways Agency staff, police authorities, highway authorities, Highways Agency Service Providers (including DBFO companies) and any other key stakeholders such as weather forecast providers. The internal document distribution should include all decision makers and managers. Where necessary, this distribution list can be included as a separate appendix to the document.

The above document control and document distribution tables should be amended to comply with individual organisations' own quality management procedures.

Documents should preferably be distributed electronically and, to preserve format and maintain document control and security, PDF format is recommended.

1 SCOPE

1.1 Introduction (Scope)

This section of the severe weather plan outlines the scope of the services provided, responsibilities for provision of those services and details the extent of the network on which the service is provided.

[Service Provider] to ensure that the operational activities contained in this plan dovetail with other Highways Agency's Winter Plans (e.g. Traffic Officer's Severe Weather Plan)

1.2 Policy Framework (Statement of Service)

1.2.1 Policy

It is the Highways Agency's policy to ensure, so far as is reasonably practicable, that safe passage along the highway is not endangered by snow or ice, and alert procedures and actions are taken in the case of floods, severe gales, fog and heat waves.

[Service Provider] must implement the Highways Agency's policy [within Area No / on the Route DBFO] in an efficient and safe manner and should endeavour, in so doing, to minimise delays to road users.

1.3 Severe Weather Warning Systems and Definitions

1.3.1 Weather Warning Systems

The National Severe Weather Warning System (NSWWS)	
Regional Advisory of Severe or Extreme Weather Warning (Advisory)	Advisories are issued by 1300 daily as routine and indicate confidence of expected severe or extreme weather. Early and flash warnings supersede advisories when confidence levels are 60% or greater.
UK Advanced Warning of Severe Weather (Early Warning	An early warning of severe weather will normally be issued up to several days in advance whenever the overall risk of widespread disruption in any UK region is 60% or greater.
Regional Severe Weather Warning (Flash Warning)	Flash warnings of severe weather are issued when confidence of an event reaching specified criteria is above 80%, and should give a minimum of two hours notice. Warnings are issued for every affected county or unitary authority.
Flood Forecasting Centre (EA/Met Office)	
Extreme Rain Fall Alert	The ERA Service is designed to alert emergency responders in England and Wales to the possibility of urban surface water flooding as a result of extreme rainfall
The Environment Agency Flood Warning System	
Flood Watch	Flooding of low lying land and roads is expected. Be aware, be prepared, watch out.

Flood Warning	Flooding of homes and businesses is expected. Act now!
Severe Flood Warning	Severe flooding is expected. There is extreme danger to life and property. Act now!
All Clear	Flood Watches or Warnings are no longer in force for this area

1.3.2 Severe Weather Definitions

The following weather definitions are provided by the Meteorological Office.

Weather	***Definition***
Heavy Snow	More than 2cm per hour of snow for at least 2 hours
Blizzards/drifting snow	a. Moderate or heavy snow combined with winds of 30mph or more with visibility reduced to 200 metres or less or:- b. Drifting snow giving rise to similar conditions
Very heavy snowfall, blizzards or drifting snow	Expected to give depths of 15cm or more potentially resulting in widespread dislocation of communications. Blizzards are severe when visibility is reduced to near zero.
Freezing rain or fog / widespread icy roads	Generally occurs when rain or fog freezes on contact with road surfaces
Heavy rain	a. Expected to persist for at least 2 hours and to give more than 1.5cm of rain within a 3 hour period or:- b. More than 2.5cm per day on already saturated ground.
Severe Gales	Repeated gusts of 70mph or more over inland areas, with a risk to high-sided vehicles being blown over.
Storms	Repeated gusts of 80mph or more over inland areas, which could cause cars to be blown out of their lane on the carriageway.
Fog	The official definition of fog is visibility of less than 1000 metres. Whereas for a motorist; visibility of less than 200 metres is more realistic. Severe disruption to transport occurs when the visibility falls below 50 metres.
Heat wave	When there is an 80% chance of extremely high temperatures on at least two consecutive days, a heat wave warning is issued. The temperature thresholds vary by region, but an average threshold temperature is 30°C by day and 15°C overnight. (source Heat-Health Watch, which operates in association with the Department of Health and the Welsh Assembly).

1.4 Service and Performance Standards

1.4.1 Winter Service Response and Treatment Times

It is the Highways Agency's objective to keep all carriageways clear of snow and ice. This is achieved by undertaking precautionary treatments and/or reactive treatments to prevent the formation of ice or accumulation of snow.

Treatment is based on the following response and treatment times:

Response time is **[1 hour]**. Response time is defined as the maximum time taken from the decision to treat until the winter service vehicles are loaded, manned and ready to leave the compound. Where the decision is taken more than one hour before the planned treatment time, the response time is no longer applicable.

Treatment time is **[2 hours]**. Treatment time is defined as the maximum time taken from leaving the compound through to returning to the compound after completion of the treatment route.

1.4.2 Risk Periods

1.4.2.1 Winter Service

Winter Service weather types include Snow, Ice and Freezing Rain/Fog.

Three winter service periods are defined, for planning and operational purposes only, as follows:

Risk	Risk Periods (months)
High	December, January and February
Low	November and March
Marginal	October and April

1.4.2.2 Severe Weather

The following weather types and their expectant risk periods are based on statistics provided by the Meteorological Office.

Weather Type	Risk Periods (months)
Floods, Heavy Rain	January through to December
Gales, Wind	January to June, September to December
Fog	October, November, December and January
Heat wave, High Temperatures	June, July and August

Risk periods may not be relevant to all contracts and therefore this section can be removed if risk periods have no operational significance.

1.5 Contractual Arrangements

Note: delete and amend the following sections as appropriate.

Winter service duties including precautionary salting, reactive salting, snow clearance and the purchase of / maintaining sufficient salt stock levels are the responsibility of the Highways Agency Service Provider.

Severe weather duties including operational considerations, alert procedures and actions are the responsibility of the Highways Agency Service Provider.

The Area Performance Team / Department's Nominee must be closely involved in any planning activities. The Joint Operating Principles states that the Traffic Officer Service must have no input into the decision making process other than providing information on network issues including recovery of abandoned vehicles to the Highways Agency Service Provider (via the RCC and NCC). Further guidance on the role of the Traffic Officer Service during the winter season will be issued before the start of the winter season.

1.5.1 Role of Employer (the Highways Agency)

The Highways Agency is responsible for following:

1) Setting the overall policy on the provision of winter services on the motorway and trunk road network.
2) Co-ordination of operations at a regional and national level at times of severe weather.
3) Overseeing operation management and performance.
4) Provision of winter service compounds.
5) Provision of winter service vehicles and equipment.
6) Provision of reserve and specialist plant and equipment.
7) Provision of ice prediction services.
8) Liaison with the media.
9) Provision of Traffic Officer Service

1.5.2 Role of Service Provider (MAC or DBFO)

[Service Provider name] is responsible for:

1) Development of the severe weather plan.
2) Implementation of the severe weather plan and delivery of service as defined in the plan.
3) Design of winter service treatment routes.
4) Procurement of weather forecasting services.
5) Day to day decision making and operational management.
6) Supply of plant, labour and materials.
7) Maintenance and operation of Highways Agency vehicles, compounds and equipment.

8) Liaison with the media (DBFO Companies only).

9) Reporting to the Highways Agency.

10) Monitoring and reviewing performance.

1.5.3 Role of Managing Agent (MA)

[MA name] is the managing agent and the engineer for the term maintenance contract and is responsible for:

1) Development of the severe weather plan
2) Implementation of the severe weather plan and delivery of service as defined in the plan.
3) Procurement of weather forecasting services.
4) Day to day decision making and operational management.
5) Reporting to the Highways Agency.
6) Monitoring and reviewing performance.

1.5.4 Role of Term Maintenance Contractor (TMC)

[TMC name] is the term maintenance contractor and is responsible for:

1) Execution of the severe weather plan and delivery of service as defined in the plan.
2) Design of winter service treatment routes.
3) Day to day operational management.
4) Supply of plant, labour and materials.
5) Reporting to the MA.
6) Maintenance and operation of Highways Agency vehicles, compounds and equipment.

1.6 Network

1.6.1 Description of Network

The Service Provider may wish to include a description of their area or route including general details or features that may impact on winter service operations and areas most likely to be affected by severe weather. Specific network features relating to winter service and severe weather should be detailed in Sections 3.2 and 4.2 respectively.

1.6.2 Extent of Network

The extent of network covered by this plan is shown in the following table and also detailed in the Area Map at Appendix A.2. The key interfaces are defined in the Interface Drawings which are included within Appendix A.3.

Road	Extent
[A999]	From [x] to [y]

Service Provider to include details of footway and cycle track routes to be treated.

Category	From	To	Route Description	Plan

The above table should include details of all footways and cycle tracks Categorised as 1a, 1, 2 and 3. There is no need to detail those at category 4 as this will simply be the remainder of the network. Plans should be included at Appendix A.2 and appropriate cross references included in the above table.

Under certain situations, winter service treatments may be undertaken on other adjacent networks. The arrangements are described in section 2.1.10.

1.6.3 Network Features

Winter specific network features can be found in section 3.2. Severe weather specific network features can be found in section 4.2

Emergency Crossings

The following table should be completed, highlighting the location and type of emergency crossings (winter service vehicle turning facilities) that exist on the network. Details of operation and maintenance of these facilities should be included in section 3.1.3.1 and appropriate cross-references included. Specifically, a cross reference to the details contained in the Contingency Plan on emergency crossing points (removable sections of barrier) should be included.

Road	Location	Type
[A999]		

Solid Vertical Barrier

The following table should be completed, highlighting the location and length of Solid Vertical Barrier that exist on the network. . Details of inspection and maintenance to these barriers should be included in section 3.1.3.2 and appropriate cross-references included. Where none exist a positive statement to that effect should be included here.

Road	Location	Type
[A999]		

1.6.4 Local Problem Areas

Include here a description and location of any known problem areas or trouble spots such as:

- *parts of the network at high altitude;*
- *areas prone to low temperature/low humidity conditions where special measures may be required*
- *sections of road of a gradient that may result in problems in certain conditions e.g. jack knifed lorries;*
- *areas commonly prone to climatic conditions such as strong cross winds that would result in drifting;*
- *any structures where differential treatments or special measure may be required, and;*
- *areas where, from experience, particular problems arise where the service provision can be hampered.*

The process for review and identification of problem areas (cross referenced to section 2.1.3) should be detailed.

Reference should be made to section 2.1.3 which must detail appropriate mitigation measures.

Location	Problem
[A999]	

2 GENERAL

2.1 Operations

2.1.1 Introduction (Operations)

This section of the severe weather plan contains [Service Provider's] detailed operational procedures for delivery of winter services and details the alert procedures and actions in the event of severe weather on the [Area No/Route DBFO] network and includes arrangements for liaison and co-operation with adjacent providers to promote delivery of a consistent and co-ordinated service across all boundaries.

Service Provider to include area specific introduction as appropriate.

2.1.2 General Arrangements and Decision Making

2.1.2.1 Process

Service Provider to include a detailed description of the process including forecast, decision, instruction, treatment, monitoring loop and command and control arrangements for both winter service and severe weather events. (Use of a flowchart process diagram is considered best practice).

2.1.2.2 Decision Maker (Definition of Roles)

Service Provider to include details of the decision maker(s) e.g. Duty Officer and definition of the role(s).

A cross reference to section 2.2.2.1 should be included.

2.1.2.3 Duty Rota

Service Provider to include duty rotas for all personnel involved in winter service and severe weather operations

The Decision Maker Duty Rota is included at Appendix A.12.

2.1.2.4 Guidance

[Service Provider] must take account of relevant Highways Agency advice and guidance including AMM's [and the Network Management Manual *as appropriate*].

2.1.3 Mitigation measures for Local Problem Areas

There are a number of known problem areas requiring special consideration within [area/route], as identified in section 1.6.4. The following table shows the considerations and mitigation measures identified in respect of these problem areas.

Location	Problem	Special Considerations & Mitigation Measures

2.1.4 Abandoned Vehicles

Where an abandoned vehicle is hampering snow clearing or clear up operations the removal from the road, or removal to another part of the road, may be required. Wherever possible the owner will be contacted and requested to remove the vehicle directly but in certain circumstances it may not be appropriate, or possible, for the owner to attend to the vehicle. Only the Police/Traffic Officers have the authority to move a vehicle in these circumstances and therefore contact will be made through normal liaison arrangements, or via the RCC, and an instruction sought from a Police/Traffic Officer for the vehicle to be moved (Where a number of vehicles have to be moved details of every individual vehicle will be given to the Police/Traffic Officer and specific instruction sought for each individual vehicle). The specific details of the vehicles, its location and the reason why it needs to be moved will be provided to the Police/Traffic Officer and a log of all communications kept**. [Service Provider] must only move vehicles once an instruction from a Police/Traffic Officer has been received.**

Where owners do leave their vehicles information relating to their location and contact details will be obtained and lodged with the severe weather desk, Network Control Centre and RCC.

Service Provider to include details of arrangements for moving vehicles including equipment to be used and procedures to be followed and contact details for relevant organisations and supply chain.

2.1.5 Road Traffic Accidents

Any road traffic accident involving [the Highways Agency's own vehicles / any winter service vehicle] will be reported to the Service Manager and the Regional Winter Service Coordinator. The report must be made on form DfT 20001 and must be submitted as soon as possible but no later than before 9am the following working day. Where the accident involves a fatality or serious injury report must be made immediately.

Service Provider to amend the above text to match contractual requirements. Where there is no contractual requirement in respect of provider vehicles, details for report should still be included.

2.1.6 Escalation

Snow and severe weather events should normally be managed by each respective area team and contingency plan arrangements must only be enacted if the planned response is insufficient to cope with exceptional weather conditions, if procedures fail or if an incident is compounded by a series of

further incidents. Emergency customer welfare arrangements are detailed within the contingency plan.

Service Provider to define escalation arrangements including specific details of how the establishment of the severe weather desk and activation of the contingency plans are related.

2.1.6.1 Establishment of Severe Weather Desk

The severe weather desk must be established prior to the forecasted commencement of severe weather that could cause disruption to the network or snow falls that are likely to be sufficient to settle on the carriageway and substantially hinder the passage of traffic or as soon as possible in the event of un-forecast snow falls or severe weather.

The severe weather desk must be established at [location].

The severe weather desk/control room will have the ability to communicate directly with motoring organisations and local authorities and to listen to/watch local news/traffic media.

Where decisions, and their implications, require strategic oversight they will be referred to the Service Manager.

The Severe Weather Desk Duty Rota is included at Appendix A.13.

2.1.6.2 Activation of Contingency Plan

This [title] contingency plan must be activated when a staff member becomes aware of a major or critical incident taking place and they must immediately put in place the actions outlined within the contingency plan.

Service Provider to include a detailed description of the escalation procedures and severe weather desk arrangements including preparation, establishment and operation.

2.1.7 Liaison and Communication

2.1.7.1 Notification of Treatments

[Service Provider] must notify the Highways Agency, [weather forecast provider], police, adjacent Service Providers and local highway authorities [others?] of all proposed treatments once known, but not normally later than 16:00 each day.

[Service Provider] must, as soon as practicable, notify the Highways Agency, [weather forecast provider], police, adjacent Service Providers and local highway authorities [others?] of other actions including changes to planned treatments, reactive treatments and snow clearance.

The WRF1 system must be used for the above notifications. Where the system is unavailable the forms at Appendix A.11 must be used.

All notifications must be made using the WRF1 system unless agreement is reached with recipients for transmission by other means.

A comprehensive external contact list can be found in Appendix A.9.

2.1.7.2 Daily Reports
Before 10:00 each day [Service Provider] must provide a daily operational report to the Service Manager, detailing the treatments carried out over the last 24 hours and any relevant issues that have arisen during that period.

The report must be submitted using the WRF1 system. Further guidance can be found in AMM 91/07 – Winter and Business Continuity Reporting Arrangements, a copy of which can be found in Appendix A.10.

2.1.7.3 Hourly Updates
When weather conditions on the network are such that the flow of traffic is hindered [Service Provider] must provide the Highways Agency with hourly updates describing the current condition of the network and detailing the ongoing and proposed winter service and severe weather operations.

The report must be submitted using the WRF1 system.

2.1.7.4 Media Liaison
In order to facilitate media liaison [Service Provider] must make available to the Service Manager and/or Highways Agency press officers such information as requested. Direct liaison with the media must only take place when directed by the Service Manager.

2.1.7.5 Internal Communication Arrangements
Internal communication is by [radio/cellular telephone].

The arrangements for backup communications are [details].

Service Provider to include details of internal communication arrangements including contingency arrangements.

A comprehensive internal contact list can be found in Appendix A.8.

2.1.7.6 Winter Service and Severe Weather Briefings for Traffic Officer Service
[Service Provider] must hold winter service and severe weather briefing sessions with the Traffic Officer Service in [Area] prior to the end of October). The contents of these sessions should identify key aspects of the Severe Weather Plan. On completion of the briefing, the Service Provider must ensure that the training register (appended in AMM xx/08) is completed by the Traffic Officers being briefed.

Due to the differing content of the severe weather plans it is expected that the briefings held by each Service Provider will not be identical. For example, these sessions should identify the following:

- Extent of the network, staff involved and various roles

- Treatment routes
- Introduction to weather conditions experienced including severe weather events and instances of ice on the network

AMM xx/09 contains further details of what the Service Provider should expect to provide in the Winter Service and Severe Weather Briefings.

A copy of AMM xx/09 can be found in Appendix A.10.

2.1.8 Liaison with major highway schemes

Service Provider to include advanced notification of any major schemes across the network and contacts for any such schemes in the table below to maintain continuity with all winter treatments and any severe weather procedures and actions.

Road	Location (e.g. junction to junction)	Type of scheme	Contact
[A999]			

2.1.9 Weather Forecasting and Road Weather Information System (RWIS)

2.1.9.1 General Arrangements

[Service Provider] obtains weather forecasting service from [provider]. The services provided are [services]. *Service Provider to include details of suppliers and contracted services for weather forecasting.*

[Service Provider] obtains ice prediction service through the Highways Agency's RWIS Bureau Service.

Faults on the RWIS Bureau Service or any of the RWIS Outstations must be reported as soon as possible to the Bureau Service Contractor or the Outstation Operation & Maintenance Contractor as appropriate. Contact details can be found in Appendix A.9.

2.1.9.2 National Domain Network of Weather Stations

Include map

2.1.9.3 Domain Arrangements

Domain arrangements are described in the following table and detailed on the Area Map in Appendix A.2.

Domain	Outstations	Routes

2.1.10 Records

Collection of good quality records is fundamental to defend against liability claims made in respect of winter service delivery and any actions taken in the case of floods, severe gales, fog and heat wave. The table below demonstrates the detailed record information that [Service Provider] must retain:

Information	Record Content	Format	Storage Media	Retention Period
Weather Forecast				
Actual Weather Conditions				
Reports received				
Decisions made				
Instructions made				
Confirmations				
Actions taken				
Liaison and communications log				
Telephone conversations including with forecast provider				
Material usage				
Fleet breakdowns				

Times taken to complete treatments				
Use of additional resources (including reserve fleet and mutual aid)				
Road Closures/blockages due to weather conditions				
Complaints received relating to conditions due to weather				

Records must be available for inspection in accordance with individual contracts

Service Provider to refer to individual contracts for details of retention period and storage media - refer to individual contracts.

2.1.11 Health and Safety

Service Provider to include a statement on Health and Safety covering the operational aspects of severe weather and winter service e.g. treatment speed, ploughing, loading and off-loading, manning levels, PPE, welfare, rations, communications and the safety of other road users.

2.1.12 Mutual Aid

Service Provider to include a statement explaining what mutual aid arrangements are in place.

[Service Provider] must take into consideration information contained within AMM 51/04 or the Network Management Manual *as appropriate*], a copy of which is attached at Appendix A.10

2.1.13 Review

Service Provider to include details of review procedures, including responsibility and criteria for review e.g. failure to meet service or performance standards, continuous improvement initiatives and end of season review.

Typical issues for the review may include:

- *response and treatment times,*
- *decision making,*
- *command and control,*
- *escalation and severe weather desk,*
- *liaison and communications,*
- *weather forecasting and ice prediction,*
- *actual weather conditions,*
- *operational issues,*
- *records,*
- *health and safety,*
- *human resources,*
- *vehicles and plant,*
- *de-icing materials,*
- *compounds and facilities,*
- *other issues e.g. traffic flow, adjacent roads etc. and*
- *areas for improvement.*
- *Identified problem areas on the network.*

2.1.14 Winter Service & Severe Weather Timetable

The following table sets out key dates in the delivery of winter service.

Date	Who	Action
8 June 09	SP	Pre-season review and preparation
21 August 09	SP	Submit Severe Weather Plan
18 September 09	HA APT	Check / accept SW Plan
18 September 09	HA NWT	Check / accept SW Plan (to HA APT)
1 October 2009		Winter Season Commences
Monthly from 1 October 2009	SP	Monthly report to include salt stocks, salt usage, position statement on salt stock levels and analysis of forward usage (AMM xx/xx)
31 March 2010	SP	Finalise list of key issues to feed into regional winter & severe weather workshops
30 April 2010		Winter Season Concludes
May 2010	SP	'May' winter & severe weather review
June 2010	SP	Winter & severe weather report to HA

Service Provider to include any other relevant dates in the table.

2.2 Resources

2.2.1 Introduction

This section of the severe weather plan contains details of the resources available for delivery of winter services and the alert procedures and actions in the event of severe weather on the [Area No/Route DBFO] Network including reserve and contingency arrangements.

Service Provider to include area specific introduction as appropriate.

2.2.2 Human Resources

2.2.2.1 Definitions

The following table defines the key personal responsible for delivery of the services defined within this document.

Function	Title	Name
Network Manager		
Duty Officer		
Decision Maker		

The above table should be completed to include all relevant Service Provider personnel. Where possible, consistency of naming should be maintained. The table should include the person with overall responsibility (Network Manager), the person who has day to day responsibility for winter service/severe weather and would be the first point of contact (Duty Officer) and the person responsible for monitoring weather and road conditions and making decisions (Decision Maker). These functions are likely to have different titles within each organisation.

2.2.2.2 Training

Service Provider to include a general statement on training together with details of qualification standards for drivers supervisors, depot supervisors and decision makers. Reference to training on this plan should be included.

Training Records are detailed at Appendix A.15.

2.2.2.3 Organogram

Service Provider to include an organogram detailing the structure of the organisation.

2.2.2.4 Manning Levels

[Service Provider] has [?] qualified drivers for winter service operations on the [Area No/Route DBFO] network as detailed in Appendix A.6, which meets the Highways Agency's specified minimum resource levels of three times the number of operational vehicles plus twenty five percent.

2.2.3 Compounds and Facilities

2.2.3.1 Compounds and Depots

A schedule of compounds and depots covering the [Area No/Route DBFO] network can be found in the compounds, depots and facilities schedule which should be included in Appendix A.7.

2.2.3.2 Fuel

The following table indicates the fuel type (including grade) and details of supply and storage arrangements including minimum stock levels.

Depot	Supplier	Fuel Type & Grade	Maximum fuel storage capacity (Gas Oil Litres)	Maximum fuel storage capacity (DERV Litres)	Minimum fuel storage (Litres)

[Service Provider] must monitor fuel stock levels regularly during the winter period.

When there is a possibility of disruption of fuel supply or when stocks are low then [Service Provider] must report fuel stock information using the WRF1 electronic reporting system by 16:00 hours on a daily basis. Details of the reporting requirements are detailed in AMM 91/07 at Appendix A.10.

The Service Provider must include within the table below details of fuel supply contingency and pump maintenance arrangements.

Depot	Contingency Arrangements	Pump Maintenance Arrangements

2.2.3.3 Other Facilities

A schedule of other facilities that are available to service the [Area No/Route DBFO] network can be found in Appendix A.7.

Examples of "other facilities" include facilities that are provided for severe weather working or as contingency.

2.2.4 Winter Service and Severe Weather Infrastructure Inventory

2.2.4.1 Description

The inventory is stored on a MS Access database containing detailed information relating to [Service Provider's] compounds and the Highways Agency compounds and winter fleet. This inventory is a database which requires updating to reflect any changes.

2.2.4.2 Database management

[Service Provider] will review and update the information held by the Highways Agency during both January/February and June/July each year.

3 WINTER

3.1 Operations

3.1.1 Decision Making and Treatment Matrix

Decisions are made primarily in the interest of service delivery and continuity and takes account of weather and decision information from adjacent Highways Agency Service Providers and relevant local authorities.

All decisions are subject to continuous monitoring, recording & review.

All winter decisions are evidence based and are made in accordance with the guidance contained within the following decision and treatment matrices:

Suggested decision making and treatment matrices for precautionary treatment are shown in the following pages. Service Providers should modify theses as necessary to suit their own specific local circumstances.

During periods of forecast severe weather [Service Provider] must remain in contact with [forecast provider] and should also take account of information from staff out on the network and from CCTV when making decisions.

Decision Matrix Guide

<table>
<tr><th colspan="2"></th><th colspan="3">Predicted Road Conditions</th></tr>
<tr><th>Road Surface Temperature</th><th>Precipitation etc.</th><th>Wet</th><th>Wet Patches</th><th>Dry</th></tr>
<tr><td>May fall below 1°C</td><td>No rain
No hoar frost
No fog</td><td rowspan="3">Salt before frost</td><td>Salt before frost
(see note A)</td><td>No action likely, monitor weather
(see note A)</td></tr>
<tr><td rowspan="5">Expected to fall below 1°C</td><td>No rain
No hoar frost
No fog</td><td colspan="2">Salt before frost
(see note B)</td></tr>
<tr><td>Expected hoar frost
Expected fog</td></tr>
<tr><td>Expected rain BEFORE freezing</td><td colspan="3">Salt after rain stops</td></tr>
<tr><td>Expected rain DURING freezing</td><td colspan="3">Salt before frost and after rain stops
(see note C)</td></tr>
<tr><td>Possible rain
Possible hoar frost
Possible fog</td><td colspan="2">Salt before frost</td><td>Monitor weather conditions</td></tr>
<tr><td colspan="2">Expected snow</td><td colspan="3">Salt before snow fall</td></tr>
<tr><td rowspan="3">Freezing Rain</td><td>Before rain</td><td colspan="3">Salt before rainfall (see note C)</td></tr>
<tr><td>During rain</td><td colspan="3">Salt during rainfall (see note C)</td></tr>
<tr><td>After rain</td><td colspan="3">Salt after rainfall (see note C)</td></tr>
<tr><td colspan="5">The decision to undertake precautionary treatments should, if appropriate, be adjusted to take account of residual salt or surface moisture.</td></tr>
</table>

A. Particular attention should be given to any possibility of water running across carriageways and such locations should be monitored and treated as required.
B. When a weather warning contains reference to expected hoarfrost considerable deposits of frost are likely to occur and close monitoring will be required. Particular attention should be given to the timing of precautionary treatments due to the possibility that salt deposited on a dry road may be dispersed before it can become effective.
C. Under these circumstances rain will freeze on contact with running surfaces and full pre-treatment should be provided even on dry roads. This is a most serious condition and should be monitored closely and continuously throughout the danger period.

Treatment Matrix Guide

Weather Conditions **Road Surface Conditions** **Road Surface Temperature (RST)**	**Air Temp**	**Treatment**	
		Salting (g/m^2)	**Ploughing**
Frost or forecast frost RST at or above -2°C		10	No
Frost or forecast frost RST below - 2°C and above - 5°C		20	No
Frost or forecast frost RST at or below - 5°C and above -10°C and dry or damp road conditions		20	No
Frost or forecast frost RST at or below - 5°C and above -10°C and wet road conditions (existing or anticipated)		2 x 20	No
Light snow forecast (<10mm)		20	No
Medium/heavy snow or freezing rain forecast		2 x 20	No
Freezing rain falling		20 (successive)	No
After freezing rain		20	No
Ice formed (minor accumulations)	above -5°C	20	No
Ice formed	at or below -5°C	2 x 20	No
Snow covering exceeding 30mm		20 (successive)	Yes
Hard packed snow/ice	above - 8°C	20 (successive)	No
Hard packed snow/ice	at or below - 8°C	salt/abrasive (successive)	No
Rate of spread for precautionary treatments may be adjusted to take account of residual salt or surface moisture unless stated otherwise within NMM 5.6.4 (extracted from AMM 36-02).			

A revised treatment matrix, including advice on pre-wet treatment, shall be provided to service providers in August 2009 prior to the commencement of the winter season.

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3.1.1.1 Special Considerations

The treatment of hard packed snow/ice using salt alone can result in an uneven and slippery surface and therefore, in such circumstances, the addition of abrasives must be considered (see section 3.3.2.1).

In low humidity conditions [Service Provider] must follow the procedures described in section 3.1.2.5.

Where the effectiveness of treatment may be affected by surface type [Service Provider] must follow the procedures described in sections 3.1.2.3 and 3.1.2.4.

Service Providers will need to adjust the treatments to suit local circumstances for example, salt stored in the open or to meet contract promises.

In circumstances where temperatures of less than -10°C are sustained [Service Provider] must implement the procedure detailed in section 3.1.2.7.

In circumstances where freezing rain is forecast [Service Provider] must implement the procedures described in section 3.1.2.6.

3.1.2 De-icing Treatment

3.1.2.1 Treatment Type

Service Provider to include details of the treatment type(s) across the network e.g. salt, pre-wetted salt, treated salt, urea etc. A reference to Section 3.3.2 and Appendix A.4 should be included

Service Provider to include details for the treatment of footways, cycle tracks and paved pedestrian areas where appropriate.

3.1.2.2 Spreading Techniques & Operational Considerations

Service Provider to include details of the spreading techniques, for different types of carriageway and location.

This section should include specific details of any sections of road of more than three lanes and describe the approach taken to ensure adequate treatment of all parts of the carriageway.

Service Provider to include operational considerations as appropriate e.g. treatment of special structures, treatment during peak traffic flow periods, road works, treatment within tunnels, road over road bridges, operations near railways and innovative trials. Full details should also be included in the route schedule (Appendix A.4) and a cross reference included within this section.

Guidance on working in close proximity to railways can be found in Circular ROADS no 18/77, a copy of which is appended at Appendix A.10.

3.1.2.3 Porous Asphalt

[Service Provider] must give special consideration to the treatment of Porous Asphalt and must take account of the information contained in the Network Management Manual a copy of which is attached at Appendix A.10.

Service Provider to include Porous Asphalt site details (including appropriate references within their treatment route schedules) and a description of the practical measures proposed.

A cross reference to section 1.6.4 and 2.1.2.4 should be included

Delete this section if not applicable.

3.1.2.4 Thin Surfacing

[Service Provider] must give special consideration to the treatment of Thin Surfacing and must take account of the information contained in the [AMM 36/02 or the Network Management Manual *as appropriate*] a copy of which is attached at Appendix A.10.

Service Provider to include Thin Surfacing site details (including appropriate references within their treatment route schedules) and a description of the practical measures proposed.

3.1.2.5 Low Humidity

[Service Provider] must give special consideration to precautionary treatments during low humidity conditions and must take account of the information contained in AMM 34/02 or the Network Management Manual *as appropriate*] a copy of which is attached at Appendix A.10.

Following events during the 2008/09 winter season additional guidance will be issued prior to the 2009/10 winter season.

Service Provider to include full details of the practical measures proposed.

3.1.2.6 Freezing Rain

[Service Provider] must give special consideration to the treatments required before during and after freezing rain and must take account of the information contained in [AMM 62/05 or the Network Management Manual *as appropriate*] a copy of which is attached at Appendix A.10.

Following research undertaken during 2008/09 further guidance will be issued to clarify the Service Providers procedures for dealing with Freezing Rain.

Service Provider to include full details of the practical measures proposed including details of the pre-treatment arrangements, procedures for warning motorists and closing roads where appropriate and necessary. The procedure should include details of reactive treatment arrangements and materials to be used, for example a salt/abrasive mix.

3.1.2.7 Sustained Low Temperatures

Service Provider to include full details of procedures for dealing with circumstances where temperatures of less than -10 C are sustained for example the addition of calcium chloride.

Further guidance can be sought from the National Winter Teams Regional Winter Service Co-ordinator.

3.1.2.8 Salt Bins and Salt Heaps

Service Provider to include full details of locations of salt heaps and salt bins and describe the re-supply arrangements.

3.1.3 Snow Clearance

3.1.3.1 Ploughing & Clearance Techniques and Operational Considerations.

Service Provider to include details and procedures for ploughing, including clearly defined decision points for the fitment of ploughs and commencement of ploughing, and plough height settings.

This section must include specific details of any sections of road of more than three lanes and describe the approach taken to snow clearance including specific details of which lanes snow is to be ploughed.

Service Provider to include procedures for bulk removal of snow including any identified areas where snow can temporarily be stockpiled.

Service Provider to include operational considerations as appropriate e.g. maintenance of snow fences, operation of snow gates, use of emergency crossings, road over road bridges, AIL (Abnormal Indivisible Load) movements and operations near railways.

It is important that all the defined routes are cleared and that no area is abandoned for the sake of concentrating resources to one or two problem areas. In all cases therefore the defined treatment routes will be adhered to, and where conditions demand a more intensive treatment in specific areas, this will be achieved by calling out a reserve vehicle for those areas.

3.1.3.2 Snow clearance and solid vertical barriers

Numerous major maintenance schemes require the installation of lengths of vertical concrete/other solid barrier throughout the motorway and trunk road network which can pose problems regarding snow clearance. New guidance provided in AMM 89/07 or the Network Management Manual as appropriate (a copy of which is attached at Appendix A10) provides the relevant information for dealing with snowfall in circumstances where traditional ploughing techniques may not be applicable due to the presence of a vertical concrete barrier.

[Service Provider] should consider whether any lanes may need to be abandoned during periods of prolonged heavy snowfall due to the problems associated with ploughing adjacent to vertical concrete barriers.

When conditions dictate it is recognised that it is acceptable to plough snow from lane 2 to the right and sacrifice one or more running lanes to stack snow whilst keeping the maximum number of lanes available to traffic for each route classification and maintaining access and egress.

[Service Provider] must produce a schedule identifying the locations of vertical concrete/other solid barrier on their network and a clearance plan for each location to be included within the Severe Weather Plan as Appendix A.16. This schedule should also be cross referenced to Appendix A.4 - route drawings and schedules. Alternatively, the schedule may form part of the route schedules.

[Service Provider] must give special consideration to snow clearance where solid vertical barriers are present and must take account of the information contained in AMM 89/07.

3.1.3.3 Aftercare and follow up Treatments

Service Provider to include details of aftercare and follow up treatments e.g. clearing side roads and lay-bys.

3.1.3.4 Arrangements for use of Blowers

Where the use of one of the Highways Agency's snow blowers is required the Regional Winter Service Coordinator, [name], will be contacted and approval sought. Where the equipment is to be brought in from another area the Regional Winter Service Coordinator will liaise, as necessary, with the National Winter Service Coordinator and other relevant parties.

[Service Provider] has [number?] operatives qualified to operate snow blowers as detailed at Appendix A.6.

Service Provider to include full detailed arrangements and procedures for the use of snow blowers including details of transport arrangements.

3.2 Network Features

The network features listed below are specific to winter operations only. Details of the general network features are located in section 1.6.3.

Snow Gates

The following table should be completed, highlighting the location and type of snow gates that exist on the network. Details of operation and maintenance of these facilities should be included in section 3.1.3.1 and appropriate cross-references included. Where none exist a positive statement to that effect should be included here.

Road	Location	Type
[A999]		

Snow Fences

The following table should be completed, highlighting the location and type of snow fences that exist on the network. Details of maintenance of these facilities should be included in section 3.1.3.1 and appropriate cross-references included. Where none exist a positive statement to that effect should be included here.

The procedures for reviewing the locations and effectiveness of existing fencing and for identifying new locations should also be described.

Road	Location	Type
[A999]		

3.3 Resources

3.3.1 Vehicles and Plant

3.3.1.1 Available Resources

A detailed schedule of vehicles and plant including operational spreaders, ploughs, loading shovels, [snow blowers] and reserve vehicles can be found in Appendix A.5.

Service Provider to include other vehicles and plant as appropriate.

3.3.1.2 Reserve Vehicle Arrangements

[Service Provider] can use the reserve fleet allocated to their Area without prior approval but must ensure the use is notified up to an agreed predetermined level. Details of the agreed national procedures for management of the reserve vehicles are detailed in AMM 81/06 and Appendix A15 – Deployment of Reserve Winter Service Vehicles.

Service Provider to include detailed local arrangements and procedures for the use of reserve vehicles including details of arrangements for transporting vehicles between areas.

3.3.1.3 Vehicle Maintenance Arrangements

Service Provider to include details of vehicle maintenance arrangements for both Service Provider and Highways Agency vehicles. Arrangements should detail who provides maintenance services, how these services are managed and call out procedures with appropriate references to the internal and external contact lists.

Arrangements for recording and reporting defects to be included here.

3.3.1.4 Arrangements for “Specialist” Equipment

Service Provider to include details for specialist equipment as appropriate e.g. specialist mixing equipment for alternative de-icing materials.

Service Provider to detail any other equipment such as loading hoppers and weighbridges including arrangements for maintenance.

3.3.1.5 Arrangements with supply chain partners

Service Provider to include details of any supply chain partner arrangements.

3.3.2 De-Icing Materials

3.3.2.1 Type and Specification

- **6mm salt, to BS3247:1991.**
- **Abrasives: 5 or 6mm sharp sand**

Additional specialist materials such urea, acetate salts, glycol, brine, ABP, etc should be specified where applicable.

3.3.2.2 Storage Locations

Service Provider to include details of storage locations and facilities. A reference to Appendix A.7 should be included. Where defined supply profiles are used, these should be included. Service Provider to copy this table as required for each material used.

De-icing Material (i.e. Dry salt/ABP)	Location	Type (barn/open)	Max (tonnes)	Min (tonnes)

3.3.2.3 Brine Production and Storage

Service Provider to include details of brine production and storage facilities where used.

Location	Type (saturator/storage only)	Capacity (L)	Min (L)

3.3.2.4 Supply Arrangements

Service Provider to include details of supply arrangements including a primary and secondary supplier. Detailed evidence must be given to confirm salt can be sourced in a timely manner. Details of monitoring and stock control arrangements must also be documented.

3.3.2.5 Reserve and Contingency Arrangements

Service Provider to include details of reserve arrangements. Details of contingency supply should also be specified including details of alternative suppliers and mutual aid arrangements with other Service Providers or local highway authorities.

3.3.2.6 Monitoring and Reporting

[Service Provider] must monitor salt stocks (and stocks of other appropriate materials) regularly during the winter period and reports made using the WRF1 electronic reporting system. When making these reports [Service Provider] must take into consideration information contained within [AMM 76/06 or the Network Management Manual *as appropriate*] a copy of which is attached at Appendix A.10.

Attention is drawn to amendments to AMM 76/06, AMM 63/05, AMM 91/07 and the NMM which will be issued in July and August 2009. The amendments will include a requirement that the Service Provider must provide evidence to justify how each salt threshold level has been set. The reporting threshold definition will be the threshold for the automatic ordering of additional salt. Service Providers will be asked to confirm salt stock profile for every month of the winter season, as opposed to a small number of key dates as previously provided.

3.4 Footways and Cycle Tracks

3.4.1 Introduction

Service Provider to include area specific introduction as appropriate.

3.4.2 Policy

3.4.2.1 Footways Response and Treatment Times

The service and performance requirements for footway and cycle track treatments are defined within [AMM 50/04 or the Network Management Manual *as appropriate*] a copy of which is attached at Appendix A.10.

The treatment of footways and cycle tracks should normally be co-ordinated with adjacent local highway authorities. Service Provider to include specific details of treatment policy.

3.4.3 Routes

Details of all routes to be treated are contained in 1.6.2

3.4.4 Operations

Service Provider to include details for the treatment of footways, cycle tracks and paved pedestrian areas where appropriate.

Service Provider to include details of the spreading technique(s) for footways, cycle tracks and paved pedestrian areas.

3.4.5 Resources

Service Provider to include details of resources to be utilised in the treatment of footways and cycle tracks.

4 SEVERE WEATHER

4.1 Operations

This section of the severe weather plan contains [Service Provider's] detailed operational procedures and actions in the event of severe weather on the [Area No/Route DBFO] network and includes arrangements for liaison and co-operation with adjacent providers to promote delivery of a consistent and co-ordinated service across all boundaries. The Highways Agency's NTCC and RCC service are responsible for arranging both strategic and tactical diversion routes and media liaison. The Service Provider is to include operational activities as detailed in the red text below.

Service Provider to include area specific introduction as appropriate, including reference to the 'Service Provider Contingency Plan' and escalation procedures in the event of severe weather. Reference to section 2.1.6 Escalation can be made if appropriate.

Service Provider to include operational considerations for each severe weather type as appropriate e.g. treatment of special structures, treatment during peak traffic flow periods, road works, treatment within tunnels, road over road bridges, operations near railways and innovative trials. Full details should also be included in the route schedule (Appendix A.4) and a cross reference included within this section.
Service Provider to make reference to any additional operational plans (i.e. M48 Severn Crossing) specific to dealing with severe weather.

4.1.1 Early Warning/Forecasts

Service Provider to detail what alerts/forecasts they will use to provide early warning of forecast severe weather (i.e. EA Flood Watch/Warning, weather forecast etc)

4.1.2 High Winds/Gales

4.1.2.1 Operation Considerations

Service Provider to include full detailed arrangements and procedures in the event of high winds/gales to include picking up debris, signage, and location of metrological equipment, treatment of the network including footways, cycle tracks and pedestrian areas where appropriate.

4.1.3 Floods

4.1.3.1 Pumping, Jetting & Clearance Techniques and Operational Considerations

Service Provider to include details and procedures for pumping, jetting and clearance techniques.

Service Provider to include any identified areas where floodwater can be pumped too.

Service Provider to include details for the treatment of carriageway, footways, cycle tracks and pedestrian areas where appropriate.

Service Provider to include operational considerations as appropriate e.g. maintenance of drainage systems liable to flooding and operations near railways.

4.1.3.2 After care and follow up treatments

Service Provider to include details for treatment to the network including footways, cycle tracks and pedestrian areas where appropriate.

4.1.3.3 Arrangements for use of Pumping and Jetting equipment

Service Provider to include full detailed arrangements and procedures for the use of pumping and jetting equipment.

4.1.4 Fog

4.1.4.1 Hazard Mitigation

Specific measures that should be considered by the Service Provider include:

- Where available fixed or mobile Variable Message Signs should be used to warn road users of the hazard. The existing established procedures for requesting VMS settings to be made should be followed well in advance. The following legend is currently the most appropriate to use – 'FOG SLOW DOWN'. This will require arrangements and protocols to be established with the appropriate RCC.

- National Incident Liaison Officer (NILO) and/or Highways Agency Press Officer should be contacted in order that the local media can be advised as necessary.

- Where available use of variable mandatory speed limits should be considered. This will require arrangements and protocols to be established with the appropriate Police Control office or RCC as part of the advance planning procedures.

Service Provider to include area specific introduction and list the procedures in place for warning motorists (i.e. use of fog detection systems if available, signage)

4.1.5 Heat wave

In the event of a heat wave where vehicles and occupants are static on the motorways and trunk roads for a long periods of time, the Service Provider shall provide support and assistance to the RCC and the Police as requested.

Service Provider to include details and procedures for the treatment of melted asphalted carriageway surfaces including bridge decks

4.2 Network Features

The network features listed below are specific to severe weather operations only. Details of the general network features are located in section 1.6.3.

4.2.1 Rivers, Streams and Brooks

The following table should be completed, highlighting the location of rivers, tributaries and flood plains which historically have caused flooding on the network. Details of water courses and areas subject to flooding from seepage of water onto the carriageway from adjacent land should also be included. Where none exist a positive statement to that effect should be included here.

Road	Location	Type
[A999]		

4.2.2 Coastal Defence

The following table should be completed, highlighting the location of coastal areas that exist on the network subject to flooding. Where none exist a positive statement to that effect should be included here.

Road	Location	Type
[A999]		

4.2.3 Bridges, Open Areas and Forest Areas

The following table should be completed, highlighting the location of forests and areas of trees most susceptible to high winds that exist on the network. Details of bridges and open areas subject to strong cross winds should also be included. Where none exist a positive statement to that effect should be included here.

Road	Location	Type
[A999]		

4.3 Resources

4.3.1 Vehicles and Plant

4.3.1.1 Available Resources

A detailed schedule of vehicles and plant including pumps and jetting equipment can be found in Appendix A.5.

Service Provider to include details for any other equipment and specialist equipment as appropriate including arrangements for maintenance.

4.3.1.2 Vehicle Maintenance Arrangements

Service Provider to include details of vehicle maintenance arrangements for both Service Provider and Highways Agency vehicles. Arrangements should detail who provides maintenance services, how these services are managed and call out procedures with appropriate references to the internal and external contact lists.

Arrangements for recording and reporting defects to be included here.

4.3.1.3 Arrangements for "Specialist" Equipment

Details of "specialist" plant and equipment available for use in severe weather conditions are contained in Appendix A.5.

APPENDICES & SCHEDULES

NOTE : To reduce the size of the Severe Weather Plan, the Service Provider may include certain appendices within a box of reference and not append these directly to the plan. Where this is applicable a note has been added at the start of the appendix. The Service Provider must agree an acceptable approach with the Area Performance Team and confirm the location of the box of reference.

A.1 Definitions and Abbreviations

Major or Critical Incident	See 'Service Provider Contingency Plan' Appendix C and Appendix D
Severe Weather Desk	
AMM	Area Management Memo
Service Manager	Area Manager, Service Manager or DR
Service Provider	MA, TMC, MAC, DBFO Co
Mutual Aid	Where one service provider may have a resource issue, a second or third (etc) service provider will assist in delivering the same goal
Collaboration	Two (or more) service providers working jointly to achieve the same results.
Sharing	Using a resource jointly with other service providers

Service Provider to complete this list including key definitions of all key terms and abbreviations used.

A.2 Area Map – *may be inserted within a box of reference*

The area plan should include, as a minimum, the following:

- *Overall extent of the network*
- *LHA boundaries*
- *Details of adjoining networks*
- *Police authority boundaries*
- *Treatment routes*
- *Weather forecast domains*
- *Ice Prediction outstations*
- *Compounds and Depots*
- *Network features (snow gates, emergency crossovers, snow fences, vertical concrete barriers, rivers, streams and brooks, costal defences, bridges, open areas and forest areas)*

In addition, consideration should be given to including the following information:

- *Topographical features such a height and areas of dense population*
- *Location of contingency supply facilities (plant, salt, fuel etc.)*

The plan should be to a scale, and of a size, to allow the above information to be displayed.

Separate maps should be included within this appendix to detail footway and cycle track treatments.

A.3 Interface Drawings – *may be inserted within a box of reference*

Standard Highways Agency interface drawings for the Area/Route network to be inserted here.

A.4 Route Drawings & Schedules – *may be inserted within a box of reference*

Service Provider to include route details, including unique reference, length, treatment time, salt usage, vehicle, base, instructions and inclusions/exclusions. A sample route schedule is shown below:

[Area No / Route DBFO] Winter Service Route Schedule (2004/2005)					
Route Number		Route Description			
Base Compound			Vehicle Type		
Salt Usage (@ 20gm^2)	tonnes		Vehicle VRN		
Treatment Time	hrs:mins		Vehicle Capacity		m^3
Special Route Features					

Part	Description (inclusions/exclusions and other special considerations)	Action (Travel/Salt)	Distance (Travel)	Distance (Treat)	Distance (Cumulative)
1					
2					
3					
4					
5					
		TOTALS			

Description column must include full and specific details of individual exclusions and inclusions such as lay-bys.

Service Provider should, where appropriate, include special 'snow ploughing', extra effort routes or supplementary high level routes.

Service Provider should include details for local problem areas or areas requiring special consideration due to e.g. different surfacing types

Where appropriate, separate 'route cards' giving more detailed instructions to drivers should be prepared and included within this appendix.

A.5 Vehicles and Plant Schedule

Service Provider to include spreaders, ploughs, loading shovels, snow blowers, pumps, jetting equipment, sweepers and other specialist plant for use in both winter and sever weather conditions. A sample Vehicle and Plant schedule is shown below:

Operational Vehicle Schedule						
Owner	Location	Type	Capacity	VRN or ID	Plough No	Route
[HA/SP]	[name]	[type of vehicle]	[m^3 for spreaders]	[VRN of Identification Number]		[route reference]

Reserve Vehicle Schedule					
Owner	Location	Type	Capacity	VRN or ID	Plough No
[HA/SP]	[name]	[type of vehicle]	[m^3 for spreaders]	[VRN of Identification Number]	

A.6 Operatives Schedule – *may be inserted within a box of reference*

Operative Schedule					
Base	Name	Winter NVQ Number	NVQ Expiry	Licence No	NVQ Coverage
[base location]	[name]	[reference]	[date]	[reference]	[H/P/S]

Key to NVQ Coverage:

H Qualified to operate Highways Agency spreaders
P Qualified to operate Provider Spreaders
S Qualified to operate Highways Agency Snow Blowers

A.7 Compounds, Depots and Facilities Schedule – *may be inserted within a box of reference*

Service Provider to include all compounds, depots and other facilities and should include full postal address, contact details, and facilities available e.g. salt storage, loading hoppers, fuel storage, back up power supply, communications, garaging, workshops, welfare, etc). A sample compounds and depots schedule is shown below:

Compounds, Depots and Facilities Schedule						
Compound, Depot or Facility Name	Owner	Postal Address	Purpose	Access Arrangements	Contact Details	Facilities
[name]	[HA/SP]	[address]	[description of purpose]	[details]	[telephone, fax and radio call sign]	[comprehensive list]

A.8 Internal Contact List

Service Provider to include contact information for the key personnel within the organisation.

A.9 External Contact List

Service Provider to include contact information for the Highways Agency (Area team, press officers, HAIL), police, adjacent Service Providers (MA, MAC, DBFO), adjacent local highway authorities, weather forecast provider, RWIS Service Provider and others. A sample external contact list is shown below:

Name	Role	Organisation	Telephone	Fax	Email
[name]	Service Manager	Highways Agency			
[name]	Regional Winter Service Coordinator	Highways Agency			
John Wainwright	National Winter Service Coordinator	Highways Agency			
Highways Agency press officers		Highways Agency			
HAIL		Highways Agency			
NTCC		Highways Agency			
RCC ([Region])					
RCC ([Region])					
[name]	Weather Forecaster	[organisation]			
[name]	RWIS Bureau Service Contractor	[organisation]			
[name]	RWIS Outstation O&M Contractor	[organisation]			
[name]	Salt supplier	[organisation]			
[name]	Vehicle Maintenance Contractor	[organisation]			

Service Providers must populate the above contact list with details of all adjacent Service Providers, local highway authorities, police authorities, supply chain organisations, and other relevant stakeholders.

A.10 Reference Documents – *may be inserted within a box of reference*

1 Trunk Road Maintenance Manual *as appropriate*
2 Circular ROADS 18/77 - Railways
3 Network Management Manual *as appropriate*
4 Routine & Winter Service Code *as appropriate*
5 [Area] Contingency Plan
6 AMM 34/02 Winter Maintenance in Low Temperatures Combined with Low Humidity Conditions*
7 AMM 35/02 De-icing and Snow Clearance within Traffic Calmed Areas
8 AMM 36/02 Winter Maintenance of Thin Wearing Courses
9 AMM 41/03 Winter Maintenance Operations
10 AMM 50/04 Winter Service for Footways and Cycleways
11 AMM 51/04 Mutual Aid Arrangements*
12 AMM 57/05 Post Incident De-briefing Arrangements – Guidance Document
13 AMM 62/05 Guidance on dealing with Freezing Rain*
14 AMM 63/05 Salt Stock Level Monitoring*
15 AMM 65/05 Winter Notification and Winter Reporting Arrangements 2005/06
16 AMM 69/06 - Snow Plough Height Settings
17 AMM 76/06 Strategic Salt Supply Monitoring*
19 AMM 81/06 Deployment of Reserve Winter Service Vehicles*
20 AMM 89/07 Snow Clearance Adjacent to Solid Vertical Barriers
21 AMM 91/07 Winter and Business Continuity Reporting Arrangements*
22 AMM 93/07 Salt Loading Hoppers
23 AMM 102/08 Winter Service and Severe Weather Briefings*
24 AMM 103/08 Snow Desk Exercises*
25 Area/Route Specific Contract Documents

Note that the inclusion of the TRMM and the above AMMs will be as appropriate to the inclusion of the Routine & Winter Service Code and Network Management Manual

** Further guidance will be issued in these areas which will supersede the existing AMM. The existing reference number is listed here for consistency*

A.11 Standard Forms – *may be inserted within a box of reference*

This appendix includes the following standard forms:

i. Notification of Proposed Treatments

ii. Daily Operational Update

iii. Hourly Operational Update

The forms should only be used where the WRF1 system has not been used for reporting.

[Service Provider name and logo]	[Service Provider address line 1] [Service Provider address line 2] [Service Provider address line 3] [Service Provider address line 4] [Service Provider telephone] [Service Provider fax] [Service Provider email]

Distribution List
[name, organisation, fax number/email]

NOTIFICATION OF PROPOSED TREATMENTS
for [Area/DBFO Route]

For the 24 hour period started at 12:00 hrs on	

Minimum Air Temperature	Minimum RST	Time RST zero

Winter Maintenance Action Required:	YES		NO	

Proposed Treatment

Route No	Route Description	Spread Rate (g/m^2)	Start Time	Comments

Additional Comments

Actioned by:		Verified by:	
Date & Time:		Date & Time:	

[Service Provider name and logo]	[Service Provider address line 1] [Service Provider address line 2] [Service Provider address line 3] [Service Provider address line 4] [Service Provider telephone] [Service Provider fax] [Service Provider email]

To
[Highways Agency Service Manager]

DAILY OPERATIONAL REPORT
for [Area/DBFO Route]

For the 24 hour period started at 12:00 hrs on	

Operational Summary

Route No	Proposed Treatment			Actual Treatment			Comments
	Spread Rate (g/m^2)	Start Time	Finish Time	Spread Rate (g/m^2)	Start Time	Finish Time	

Additional Comments

Recorded by:	

[Service Provider name and logo]	[Service Provider address line 1] [Service Provider address line 2] [Service Provider address line 3] [Service Provider address line 4] [Service Provider telephone] [Service Provider fax] [Service Provider email]

To
[Highways Agency Service Manager]

HOURLY OPERATIONAL UPDATE

for [Area/DBFO Route]

Date	Time

Network Summary

Network Status Summary		
Road No	Condition	Ongoing Operations

Operational Report

Recorded by:	

A.12 Decision Maker Duty Rota

A.13 Severe Weather Desk Duty Rota

A.14 Training Records – *may be inserted within a box of reference*

A.15 Deployment of Reserve Winter Service Vehicles

1. Service Providers may use 100% of the reserve spreaders allocated to their area to cover for breakdowns or extra effort without approval from the HA.

2. Service Providers must record the issue of each reserve vehicle on the WRF1 Winter and Business Reporting System in accordance with AMM 91/07 (Near to Real-time – within 30 minutes). In severe weather, it is important that Service Providers keep the WRF1 reporting system updated.

3. Reserve spreaders are also available to DBFO Cos but must be operated by drivers that have received the certified training. When required, a DBFO Co should arrange with the appropriate Service Provider to obtain the vehicle. If the DBFO Co is unable to secure a reserve vehicle, contact should be made with the National Winter Co-ordinator. The issuing Service Provider is responsible for recording the issue on the WRF1 system.

4. Reserves that are no longer needed must be returned to their operational centre and the WRF1 reporting system updated accordingly. Reserves are issued for specific tasks and may be withdrawn for re-deployment elsewhere should the need be greater.

5. The National Incident Liaison Officer (NILO) will monitor the issue of the reserve HA Salt Spreaders nationally using the WRF1 Winter and Business Continuity Reporting System.

6. Amber Alert - For the purposes of reserve fleet management, an amber alert is activated when any areas threshold level is reached (as agreed between the service provider and Area Performance Manager).

7. Red Alert - a red alert is reached when either 50% of a division's reserve or 100% of a region's reserve is utilised.

8. The numbers of HA reserve spreaders and the agreed amber and red alert trigger levels specific to the area, region and division must be recorded in the following table.

	Area X	XY Region	Z Division
Number of HA Reserve Spreaders	Enter No	Enter No	Enter No
Amber Alert – Number utilised	Enter No	N/A	N/A
Red Alert – Number utilised	Enter No	Enter No	Enter No

9. Network Performance Managers (NPMs) will be responsible for a whole division on an on-call basis and may utilise any of the Division's reserve fleet anywhere within that Division (some divisions may vary).

10. The NILO will advise the NPM and National Winter Co-ordinator when the situation becomes amber. For amber alerts, contact will not be required outside normal working hours.

11. For amber alerts, the National Winter Co-ordinator may contact the NPM to discuss the deployment of reserve fleet if he considers the situation needs elevating. This will be a pragmatic view.

12. The NILO will advise the NPM and National Winter Co-ordinator when the situation reaches red alert. If out of hours, contact will be made with the NPM and National Winter Co-ordinator on-call.

13. For red alerts, the National Winter Co-ordinator will contact the service provider to discuss the use of reserves. The National Winter Co-ordinator will then contact the NPM to discuss the deployment of the reserve fleet and any requests to deploy additional vehicles. The NPM will be requested to sanction further deployment of fleet, based on advice from the National Winter Co-ordinator taking account of the reason for reserve usage, the current road/weather conditions and the weather forecast.

14. Only if the NPM and National Winter Co-ordinator consider the situation to be a 'critical incident' will the Senior Officer on-Call (SOoC) be contacted by the NPM. The SOoC can then decide whether to call into action the National Crisis Management Team. It may be that the SOoC decides that it is a 'critical incident' irrespective of the reserve fleet utilisation.

15. The Service Provider will be responsible for the deployment of snow blowers within their area. When deployed the NPM and National Winter Co-ordinator will be notified in normal working hours only.

A.16 Solid Vertical Barrier Schedule and Clearance Plan – may be inserted within a box of reference

Solid Vertical Barrier Location Schedule

Solid Vertical Barrier Reference Number: [Reference to network map]	
Location	[Location in relation to: marker posts for Motorways/ relevant landmarks for APTR]
Cross Sectional Position	[Location in Verge or Central Reserve]
Distance from Adjacent Running Lane	[Distance from Barrier to nearest running lane]
Construction of Adjacent Verge	[Grass / Hardened / Filter Drain / V-Channel etc.]
Number of Running Lanes	[Number of Running Lanes adjacent to barrier]
Hard Shoulder Details	[Details of any hard shoulder present – Width, any other features]
Slip Roads Present	[Details of any diverging/merging slip roads present at the location]
Large Hatching Areas	[Details of any large hatching areas present - for example near diverge/merge tapers]
Resources Required for Echelon Ploughing	[Resources required for echelon ploughing including any plant required for bulk clearance]
VMS Available	[Details of VMS present - Mobile VMS required or barrier in location with permanent VMS]
Additional Non-Dedicated Vehicles	[Details of non-dedicated vehicles that will assist in clearance]
Assistance from External Sources	[Details of assistance required from such entities as Traffic Officers, Police, RCCs etc.]

Annex 5.3.1 Thermal Mapping Specification (Ref. no HM-TM1 1988)

i. Introduction

The Service Manager encourages the Service Provider to install ice prediction systems as an aid to improve forecasts of road conditions, leading to a more cost effective winter maintenance service. Specification number TR2020C and TR2013A describes how such systems operate in the interests of a National Ice Prediction.

The following specification details the parameters to which companies offering thermal mapping services are required to operate, the weather conditions under which they should be carried out, and the format in which the results should be presented to the Service Provider. The Service Provider should ensure that firms appointed to carry out thermal mapping do so in accordance with this specification.

ii. Definitions

Minimum Road Surface Temperature: The lowest temperature reached by the road surface at a given point during the night. (The minimum road surface temperature normally occurs at about the time of sunrise).
Route Survey: The observation and recording of all spatial and other factors on an adjacent carriageway that can significantly affect minimum road surface temperature. (e.g. Road construction, emissivity, orientation, slope, embankments, cuttings, trees, etc).
Thermal Survey: The measurement and recording of spatial variations of road surface temperature using passive infra-red sensors.
Thermal Map: The representation on a road map (typically at a scale of approximately 1:50,000) of the spatial variations of minimum night-time road surface temperature.
Thermal Mapping: The process of producing a thermal map. This includes the measurement of road surface temperatures, the application of any corrections required to calculate road surface temperatures at a particular reference time and the presentation of the results.
Reference Time: A single time to which observations from a thermal survey are corrected, so eliminating the influence of temporal changes in road surface temperature when surveys take a significant length of time.

iii. Applications of Thermal Maps

Road surface temperature varies in both space and time. It is dependent on certain fixed factors such as altitude, topography, road construction and sky-view factor and on variable factors such as traffic density and weather conditions. This way these factors control road surface temperature is described later in this Annex. Thermal maps, which depict the spatial variations in minimum road surface temperature, have several applications which include either:

(a) identification of those points on the road at which road surface sensors should be installed to provide the most complete and representative information on road surface conditions possible with a small number of sensors; or

(b) indication, for particular weather conditions, of how the minimum road surface temperatures at all mapped points on the Network are related to the minimum road surface temperature at those points where measurements and/or forecasts are available.

iv. Specification

Thermal Surveys

(a) Thermal surveys must be carried out between midnight and sunrise during the months November to March. Outside these periods i.e. between sunrise and midnight during the winter

months and at any time between April and October variations in roads surface temperature depend more on traffic density and the receipt of solar radiation during the day, than on the loss of terrestrial radiation at night.

(b) Each survey must be labelled with the date and time.

(c) The resolution of recorded road surface temperature data must be 0.□°C or better and the accuracy must be 1.°C as demonstrated in calibration checks. This accuracy must be maintained over the full operational range of the equipment used for the thermal survey.

(d) The average road surface temperature for a given run must not be greater than plus □°C.

(e) Measurements of road surface temperature must be made at least every 20 metres along the road, although it may be necessary to take closer readings (every 5 metres, say) in areas where sensor locations are being identified. Actual siting of sensors will be restricted by the availability of power and telephone services. Where possible sites must be chosen so that vandalism of roadside equipment is unlikely.

(f) The value of emissivity of the road surface used to derive each road surface temperature must be recorded.

(g) The state of the road surface at the time of the thermal survey must be recorded (i.e. dry, wet, frost, ice or salt).

(h) For each thermal survey a detailed description of the prevailing weather conditions must be provided. This must include:

(i) Cloud type, amount and cloud base height (low, medium or high). This information may be obtained from the Forecast Provider;

(ii) Wind speed and direction. Actual height at which the wind is measured to be stated. Measurements to be corrected to a height of 2 metres using Table A5.3.1

(iii) Air temperature (at a height of 1.25 m);

(iv) Dew point temperature (at a height 1.25 m).

Table A5.3.1 Wind Speed Correction Factors

Height of wind observation (m)	Multiplying factor to be used to obtain wind at 2 m height	
	cloudy and/or windy	clear, very light winds
1	1.2	1.3
3	0.9	0.9
5	0.5	0.5

The above measurements must be made at a point representative of the area of the survey and at the start and end of the survey. The forecasting organisation may be asked to provide supplementary weather details from the nearest weather station. Conditions must be recorded at least hourly. The description must also include text describing changes in weather conditions along the route which are not adequately defined by the above information.

When ground based thermal surveying techniques are used, surveys of both sides of a dual carriageway are not normally necessary but must be done if the two carriageways diverge significantly or differ in construction, as in the case of an 'old' road forming one carriageway of a dual carriageway. Where there is more than one lane, data is ideally required for the right-hand lane which is normally colder. However, as no vehicle must run continuously in the right-hand lane,

measurements must be taken in the centre lane of a 3 lane carriageway or the left-hand lane of a 2 lane carriageway. Sample runs in the right-hand lane must be made to establish the relationship. The police must be informed if surveying is likely to cause problems for traffic. Aerial surveys automatically include both carriageways plus hard shoulders, verges and adjoining land.

Survey times must not be greater than one hour, preferably less. However, if a thermal survey lasts more than 1 hour it is essential to survey parts of the route(s) twice to quantify changes in the road surface temperature with time, to enable all temperatures to be adjusted to a common reference time, preferably around the time of minimum road surface temperature.

v. Route Surveys

The route survey must provide the following information:

(a) Reference to the Service Provider's Section Referencing system and to other major features such as bridges and main interchanges;
(b) Changes in road surface type with reference points (e.g. black top, concrete or elevated);
(c) Presence or absence of trees, hedges, buildings, cuttings and embankments (if they dominate or have influence upon the road surface temperature).

Note: All the above must be identified within the Service Providers Section Referencing system.

vi. Weather Conditions for Thermal Surveys

Thermal surveys may be required in any of the following conditions:

(a) Calm and clear: wind speed less than 6 knots at 2 metres height, with negligible amounts of low and medium cloud

(b) Windy and cloudy: wind speed more than 6 knots at 2 metres height, thick low cloud;

(c) Intermediate conditions: surveys here will require individual analysis but can be helpful to show the sort of variations which occur between the two extremes covered by (a) and (b). Particular care is required for non-uniform cloud situations as the cloud will be a significant factor. Preference must be given to windy and clear conditions or to calm and cloudy conditions, if possible.

The number of thermal surveys required and the weather conditions in which they must be carried out depends on the use to be made of the resultant thermal maps. If the thermal map is to be used only for sensor site selection, a single thermal survey made in calm and clear conditions may suffice, but this is a minimum requirement. One single run, even under clear calm conditions, will not necessarily give a representative thermal map, although one airborne survey will provide rapid synoptic imaging with high spatial resolution along an entire route corridor.

If a thermal map is required as an aid to the prediction of road surface temperature and the management of winter maintenance, a series of thermal surveys (usually 5) must be made under different weather conditions. The Service Provider must consult its local forecasting organisation to advise on how many runs are required. (e.g. Extra surveys may be required for different wind directions where there are important local influences like conurbations or coasts and hills).

vii. Results in Digital Form

For each survey, the results of all runs carried out are be provided in digital form as shown in Table A5.3.2

The following information must be given at maximum intervals of 20 metres:

(a) Position along road (in metres from CHART nodes);
(b) Emissivity used to correct observations to road surface temperature, to 0.5%;
(c) Temperature (°C), recorded with a resolution of 0.2°C;
(d) Corrected temperature (°C), also to 0.2°C, at a common reference time, after correction to account for the duration of the survey;
(e) Two further temperatures, (as required, referring to right-hand lane as (a) to (d)).

This data must be preceded by a file giving date, time and position relative to the Service Provider's reference points at the start and end of the survey. When a survey involves an out and back or circuitous traverse, this information must also be given for the turning points of the traverse. The file must also include the survey reference point, the reference time to which the temperature measurements are corrected, and whether temperature data are given for both right-hand and left-hand lanes of the road (right-hand and middle lanes for a 3 lane carriageway). The file must also contain a detailed description of the prevailing weather conditions at the start and end of the survey and ,for long surveys at intermediate hours.

viii. Tabular Data

The data from the route survey must be given as specified in v above. For each survey, a detailed description of the prevailing weather conditions must be provided, as detailed in iv above.

ix. Results in Pictorial Form

The digital data, corrected to the survey reference time, must be used to show the variation of temperature along the survey route in graphical form for each survey.

In addition, composite maps constructed from the individual survey must be provided. These must be drawn for each of the weather conditions in section (vi). However, only one, depicting the first of the extremes, is required when thermal mapping is being done purely for sensor site selection.

All map data must be at a scale of 1:50,000.

Colours representing 1°C temperature bands must be used to identify variations in temperature on maps. The colour coding must be clearly stated: it is recommended that the colours used must be from the sequence (coldest temperature first) blue, green, yellow, orange, red, with a further subdivision of dark and light blue and green when wide variations of temperature are encountered. The horizontal resolution must be 50 metres, or as otherwise specified.

x. Explanatory Text

The maps must be accompanied by text explaining the variations of temperature along the routes, with long-sections provided to amplify the text. Further interpretation is required, giving areas which the surveys have shown to possess similar thermal climates and groupings of routes with similar temperature profiles.

Table A5.3.2 Format of Digital Data

Item No	Description	Character format
1	Route description, including location references at start and end of survey, and at intermediate points on the route. Place of measurement of air temperature, wind speed, cloud.	up to 1024 ch. in length
2	Survey date (DDMMYY)	I6
3	Start time (GMT) (HHMM)	I4

Item No	Description	Character format
4	End time of survey (GMT) (HHMM)	I4
5	Height of dry bulb and dew point measurements (m)	F4.2
6	Height of wind speed measurement (m)	F5.1
7	Start air temperature (°C)	F5.1
8	Start dew point temperature (°C)	F5.1
9	Start cloud cover (0-8), cloud type+ and cloud base height (ft)	3(I1, Char, I5)
10	Start wind speed (knots), as measured, and corrected to 2 m height, and direction	2 I2 Char*3
11	End air temperature, dew point, cloud, wind speeds and direction	2F5.1, 3(I1, Char, I5), 2I2, Char*3
12	Number of intermediate (hourly) meteorological observations	I1
13	Start time of intermediate meteorological observations (HHMM)	I4
14-37	Hourly intermediate observations as 7-10 above	2F5.1, 3(I1, Char, I5), 2I2, Char*3
38	Reference point (8 figure National Grid Reference (NGR)) from which survey distances are measured	I8
39	Reference time to which survey temperatures are corrected (HHMM)	I4
40	Indicator for lane carriageway. 1. middle/left-hand lane only; 2. right-hand and middle/left-hand lane surveyed	I1
41-??	Time (HHMM, every kilometre); Distance (in m); Emissivity used to correct observations to RST (%); Road temperature °C) to 0.□ °C; Estimated temperature at reference time after correction to allow for survey duration; 2 optional further temperatures if right-hand lane data are also available	(I4,I6,5F5.1)
Note: + L = low cloud (base <8000 ft); M = medium cloud (base 8000-20000 ft); H = high cloud (base > 20000 ft)		

xi. General Notes on the Results

The number of copies of maps, 'fingerprints', drawings, reports etc must be supplied in accordance with the Service Provider's requirements.

When the Service Provider has requested advice concerning the location of sensors, a list of representative sites must be produced, ranked in order of priority. This will enable a final selection to be made, also taking into account other factors such as the availability of power and telephone lines and security considerations.

The information provided in vii to ix above must be sufficient to enable ice prediction systems to be designed and implemented.

Factors Controlling Road Surface Temperature

i. Introduction

The surface temperature of a road is determined by its construction, its location, its surroundings, the traffic it carries, the weather (particularly the air temperature) and the time of day and season. This section describes how these factors exert their influence on road surface temperature.

ii. Temporal (diurnal) Variations in Road Surface Temperature
Road temperature is determined by heat exchanges between its surface and its surroundings. Generally the surface of the road gains heat by absorbing short-wave radiation from the sun and sky and long-wave radiation from the sky, clouds, buildings, trees, etc. The road surface loses heat by radiating long-wave radiation both day and night at a rate depending on its temperature. It also exchanges heat with the body of the road at a rate which depends on road construction and core temperature. Normally the radiation exchange results in a net gain of heat during the day and a net loss of heat during the night. The road surface also exchanges heat, by conduction and convection, with air in contact with it. The rate of this heat exchange depends on the temperature difference between the road and the air, the wind speed, the humidity and the road wetness.

The heat exchanges result in a diurnal regime of road surface temperature in which the maximum normally occurs in the early afternoon and the minimum usually around dawn. Immediately after sunset road surface temperature falls rapidly, but this decline levels off so that during the latter part of a winter night, road surface temperature falls at a lower rate. After sunrise it usually increases rapidly and this increase is often aided by increasing traffic flow.

The diurnal variation of road surface temperature at any point is affected by weather and traffic which influence the time of maximum and minimum temperature and also the amplitude of the diurnal change.

iii. Altitude and Topography
Normally the lower part of the atmosphere is kept well mixed by the wind, and air temperature falls with height at an average 'lapse rate' of about 6.□ ºC per 1000 metres. On windy and cloudy nights, road temperature is very similar to the temperature of the air near its surface, and the lowest road surface temperatures are found on the highest hills.

However, on calm and clear nights the exchange of heat between the road and the air is much less efficient, and the road surface temperature can fall several degrees below that of the air above it. The lowest road temperatures then usually occur in the places where the wind is lightest, that is in hollows and valley bottoms. Further, the air temperature in the lowest layer of the atmosphere on these occurrences may increase with height; this is known as an inversion.

In some circumstances, where there is a large variation in altitude, the highest temperature may be experienced in middle altitudes between the cold hill tops and the cold valley bottoms.

iv. Sky-view
An open level road with no adjacent buildings, hedges or trees is fully exposed to radiation from the sun and sky. It can also lose the maximum amount of heat by long-wave radiation to the sky. Radiation loss from the road is reduced by buildings, trees, hedges, cuttings, etc., all of which emit much more radiation towards the road at night than would the portion of the sky that they obscure. Hence, roads in cuttings, under bridges or lined with trees or buildings may stay warmer at night than more exposed roads.

Conversely, such sheltered roads may warm more slowly than exposed roads, if direct solar radiation cannot reach their surfaces in the early morning.

v. Road Construction
Road construction is important because heat is absorbed, stored and released from a road according to its thermal properties. Depth of construction is important too - usually the greater the depth of construction the warmer the road. As a result motorways are normally warmer at night than other roads, and concrete roads are frequently warmer than bituminous roads.

Where a road crosses a bridge, it is likely to be colder due to its shallow construction. However, bridges over water may be less affected as a result of radiation received from the relatively warm water.

vi. Urban Heat Islands

The centre of a large town or city is often several degrees warmer than the surrounding rural areas; this is known as the urban heat island effect. The relatively high temperature in urban areas is the result of industrial, commercial and domestic heat sources within the city allied to the facts that the fabric of the urban environment retains heat to a greater degree than rural areas, and the average sky-view factor for the roads is lower in an urban area.

On nights with light winds, warmer air drifting from an urban area may keep road surface temperature relatively high in the rural area just down wind of a city. Therefore wind direction can be crucial.

vii Traffic

Traffic tends to keep a road warm at night by reducing the sky-view factor, and stirring the air above the road, mixing cold air near the surface with warmer air from above, and so increasing the transfer of heat from the air to the road. Traffic also has a more direct heating effect by transferring heat by conduction to the road from tyres warmed by friction and by radiation from exhausts and engines. Vehicles tend to concentrate in the nearside lane of a road and so inside lanes are generally warmer than outside lanes at night. This phenomenon is most significant on motorways that carry a high volume of traffic at night and temperatures across a carriageway may vary by ı°C or more because of differences in the volume of traffic between lanes. "Peak time" traffic flows can also lead to variations between carriageways.

viii. Weather

Unless a road is provided with an artificial source of heat, weather is the major factor controlling road surface temperature. All other factors modify the effects of the weather on different sections of a road network. When the weather is windy and there is a complete cover of low cloud, variations of road surface temperature across the road network are at a minimum and the road temperature is very similar to the air temperature. However, when the sky is clear and the wind is light, topography, road construction, sky-view factor, traffic and urban heat sources have their greatest effects, and the variations of road surface temperature throughout the road network at their maximum. In these conditions road surface temperature at night may be several degrees lower than the air temperature and during the day it is often more than ĩ°C higher than the air temperature.