



Winter Service Research & Development

Salt Spread Rates, Holdover, and
Potassium Acetate Review

29/04/2026

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Amey

 national
highways

Presentation Agenda

- Project Background, Motivation, & Partnership
- Application to LHA & best practice
- Salt Review
- Potassium Acetate
- On-road testing & outcomes
- Research benefits to LHA's
- What's next



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- Interactive engagement throughout
- Anonymous
- Smartphone or web tab required
- Closure - Questions & Answers

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Product Solutions Pricing Resources Enterprise

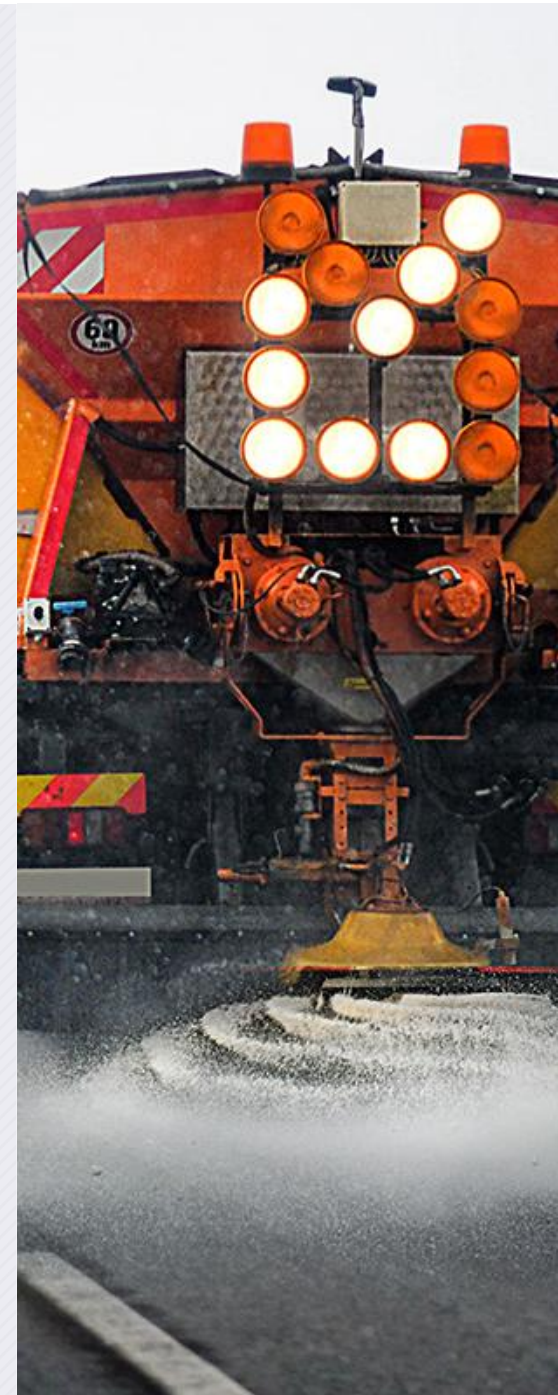
Joining as a participant?

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Winter Service Introduction

- **Legal Requirement: Section 41 Highways Act 1980** → highway authority are under a duty to ensure, so far as is reasonably practicable, that safe passage along a highway is not endangered by snow or ice
- Highway Authorities must provide **winter service** on adopted public highways
- Purpose is to assist road users:
 - Treating roads to **mitigate ice and snow**
 - Maintaining safe traffic and pedestrian movement
 - Minimising environmental impact of operations
- Roads are typically treated with rock salt or pre-wetted salt to prevent ice on roads by **lowering the freezing point of water**.
 - Salt (ice prevention)
 - Grit / sand (grip)
- **Specialist gritters / spreaders** conduct treatment
- **Winter service is essential** for → Public safety & supporting the local & national economy
- Winter service is typically **prioritised** based on route priority





Are you involved with winter service?

Background & Motivation

What changed:

- **Asset Support Contracts** → contractor made winter treatment decisions guided by their businesses risk appetite
- **Asset Delivery** → National Highways accepted the last Asset Support Contract winter plan and thus accepted a similar risk appetite

State of play:

- Salt treatment approaches were slightly different across Asset Delivery Areas
- National Highways risk appetite was not well understood → spread rate/frequency increases
- Similar increases seen with Potassium Acetate usage on the network too

What we set out to achieve:

- One National Highways network - areas aligned with a consistent and coherent evidence-based winter service approach
- Decision Makers to be confident in our guidance, processes, and spread rates
- Winter service that aligns with National Highways NetZero and Salt Strategy



The Project – Salt Spread Rates, Holdover, and Potassium Acetate Review

Task 1 – Salt spread rate review



- Reviewing the current best practice guidance within National Highways and wider industry

Task 2 – Longevity & frequency of treatments review

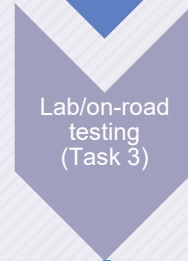


- Understanding where each Asset Delivery Area is with their current practices
- Reviewing the reasons/justifications
- Forming a base line on spread rates, holdover and Potassium Acetate usage

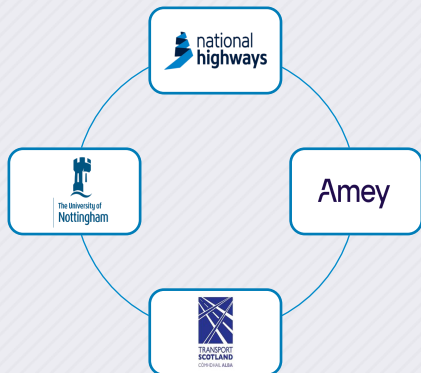
Task 3 – Potassium Acetate review



- Considering safety and costs, as well as environmental impacts and carbon emissions
- Task 3 includes asset protection cost benefits as well



- Likely only necessary for Task 3 but within scope for Tasks 1&2 as well



Will support internal guidance & treatment matrixes with robust research and testing for a consistent winter service across National Highways

LHA research benefits & best practice documentation

Application to MHA

- Recognition LHA's provision of winter service
- Best Practice Documentation - NWSRG
- Validation of NWSRG Practical Guidance (used by many LHA)
- Strategic (SRN) benefits, targeted LHA application opportunity
- Example of UK collaboration
- Raising profile on winter service R&D – art of the possible



Salt – Review of treatment matrix / spread rates

Task 1 – Salt Spread Rates Review

- Literature review validated NWSRG guidance rates
 - Included the latest research from peer reviewed literature
 - Comparisons with European counterparts

In turn;

- Validated our template treatment matrix rates (salt)
 - Dry & Pre-wet application rates
 - Including during snowfall and other hazards

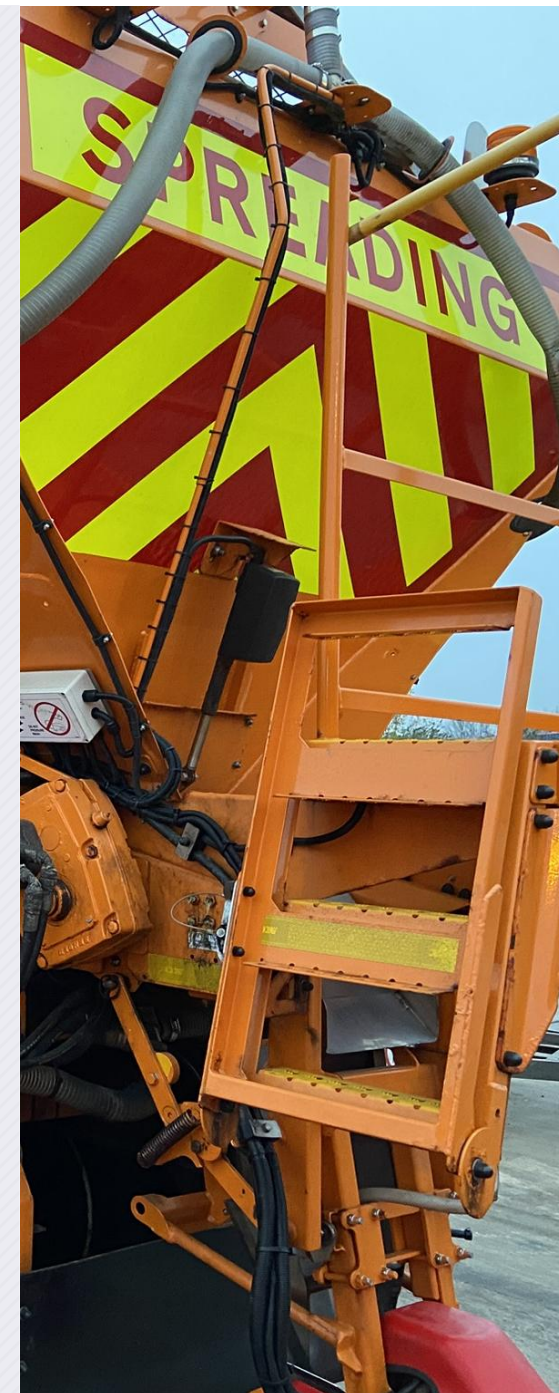
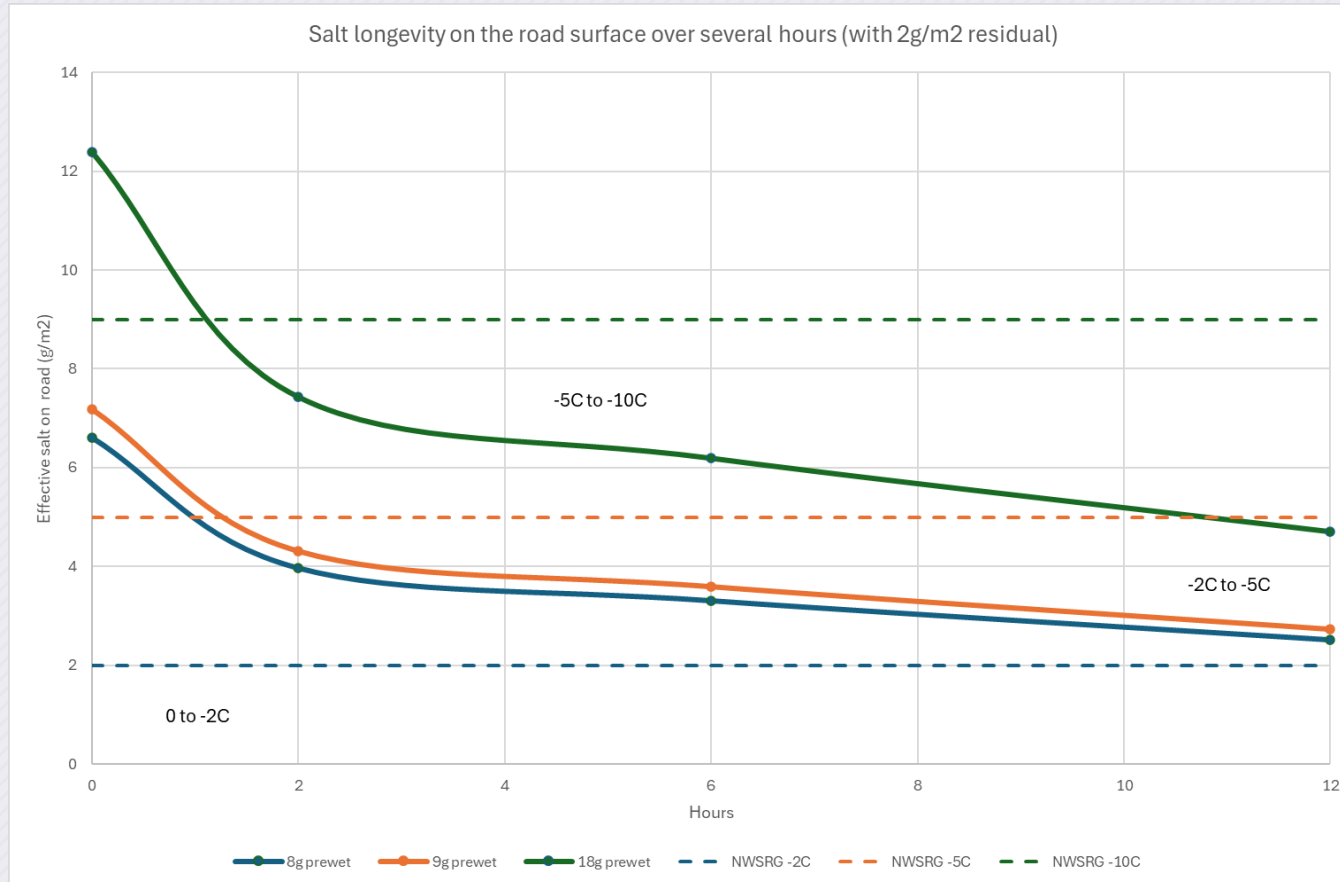
7.2 Treatment Matrix Guide					
Weather Conditions Road Surface Conditions Road Surface Temperature (RST)		Air Temp	Treatment		
			Dry Salting (g/m ²)	Pre-wetted Salting (g/m ²)	Potassium Acetate (g/m ²)*
<p>Spread rates for pre-wetted salt are the combined weight of dry rock salt and brine combined at 70:30 proportions by weight respectively with a brine concentration between 20% and 23%.</p> <p>Pre-wetted salting is the preferred precautionary treatment whenever possible, including before snowfall, where conditions and forecasts permit.</p> <p>Treatments should be carried out, whenever possible, after traffic has dispersed standing water. Successive half rate treatments (for both pre-wet and dry salt operations) should be considered for lightly trafficked roads, ² or on more heavily trafficked roads at times of low traffic e.g. Sunday mornings, at the lower end of temperature bands indicated.</p> <p>The effectiveness of salt decreases as temperatures fall and effective treatments may not be guaranteed with salt towards the lower end of the temperature band. The use of alternative treatment materials must be considered when spreading at (the lower of air or road surface) temperatures below -7°C or below -5°C in low humidity conditions (relative humidity <80%).</p> <p>The rate of spread for precautionary treatments may, if appropriate, be adjusted to take account of residual salt or surface moisture.</p> <p>The spread rates are not applicable to very wet roads, when there is standing water or spray generated, or for hoar frosts. In these conditions roads should be closely monitored and consideration given to increasing the spread rate, making successive treatments or both.</p> <p>*PA concentration rates not detailed and may influence increase or decrease in spread rates. Areas should also take into account PA manufactures/suppliers recommended spread rates.</p>					
1.	Frost or forecast frost RST at or above -2°C		8	8	18
2.	Frost or forecast frost RST below -2°C and above -5°C and dry or damp road conditions		10	9	18
3.	Frost or forecast frost RST below -2°C and above -5°C and wet road conditions		16	15	18
4.	Frost or forecast frost RST at or below -5°C and above -10°C and dry or damp road conditions		18	18	18
5.	Frost or forecast frost RST at or below -5°C and above -10°C and wet road conditions (existing or anticipated)		2 x 15	2 x 15	18
6.	Light snow forecast <10 mm		20	18	2 x 18
7.	Medium/heavy snow or freezing rain forecast		2 x 20	2 x 18	2 x 18
<p>When ice has formed, or snow is lying dry salting is the preferred treatment unless the road is closed to traffic when pre-wetted salting may be used. Pre-wetted salting is the preferred treatment in advance of such conditions.</p> <p>For snow covering forecast to exceed 30mm ploughing should be conducted early enough to ensure snow accumulations do not exceed 10mm. The rates in the table are for precautionary salt treatment prior to snowfall which is essential to form a debonding layer and aid snow clearance.</p>					
8.	Freezing rain falling		20 (successive)		18 Successive
9.	After freezing rain		20		18
10.	Ice formed (minor accumulations)	> -5°C	20		18
11.	Ice formed	≤ -5°C	2 x 20		18
12.	Hard packed snow/ice	> -8°C	20 (successive)		26
13.	Hard packed snow/ice	≤ -8°C	salt/abrasive (successive)		26



Salt – Holdover

Task 2 – Longevity & Frequency of Treatments Review

- Confirmed up to 12hr treatment frequencies (with caveats)
 - Review of research completed by Transport Scotland
 - Regional interviews with experienced practitioners



Salt – Recommendations

Task 1&2 - Additional recommendations for National Highways guidance improvements:

- **Road State Classification** – improved clarity required moving to latest NWSRG values/table
- **Sleet & Hail** – addition of specific guidance related to treatments of these hazards
- **Forward Planning** – although already completed by our regions, the addition of practical guidance as to the use of 2-5 day forecasts for early mitigation measures was formalised.
- **Alternative Snow Treatment Approach** – introduced an additional treatment option utilised in a specific Area to improve resilience during pinch points in depots
- **Salt Wicks/Bags** - Addition of practical guidance related to seepage and run-off



Salt – Summary

- **Task 1 Salt Spread Rate Review**

- Alignment in spread rates across the SRN for the 1st time in over a decade (as of 24/25 winter season)
- Estimated financial saving at £100k pa in Opex

- **Task 2 Longevity & Frequency**

- Improved clarity for decision makers and regional severe weather planners enabling regions to align further.
- Estimated financial saving at £140k pa (one region moving from 8hr-->12hr frequency)

- **Additional benefits to the research**

- Improved and clearer guidance for specific hazards and processes
- Organisations risk appetite better defined – legal liabilities reduced
- Carbon savings of around 44t eCO₂
- Reduced environmental impact





Which part of Task 1 and 2 resonates most with your LHA or MHA community?

Background & Motivation

What is Potassium Acetate?



Non-corrosive liquid de-icer primarily used by National Highways in the southwest on the road bridges – Severn Crossings and Avonmouth Bridge.



Replaced highly environmentally damaging products such as glycol and urea used in the past.



Expensive compared to salt but longer-term benefits are reduced maintenance costs and increased longevity of sensitive assets.



Primarily used in aviation as a runway de-icer.

Background & Motivation

Why are we doing the research?



Lack of Guidance

Very little research into highway usage has been carried out with application rates based mainly on theoretical calculations derived from research in the 80s/90s.



Financial Incentive

Potassium Acetate is an expensive de-icer compared to regular sodium chloride salt, so being more efficient in our usage benefits our operational expenditure.



National Highways NetZero Strategy

Potassium Acetate has a much greater carbon footprint than rock salt so increasing efficiency and reducing our usage will have an impact on our drive for NetZero.



Environmental Aspects

Although Potassium Acetate is much more environmentally friendly compared to its predecessors, it can still reduce oxygen levels in water courses.



Laboratory Testing

Differential Scanning Calorimetry (DSC)

- Used to obtain the heat flux during a materials phase change.
- Tested different concentrations of potassium acetate solution (2% / 5% / 10% / 15%) to simulate dilution on the road.

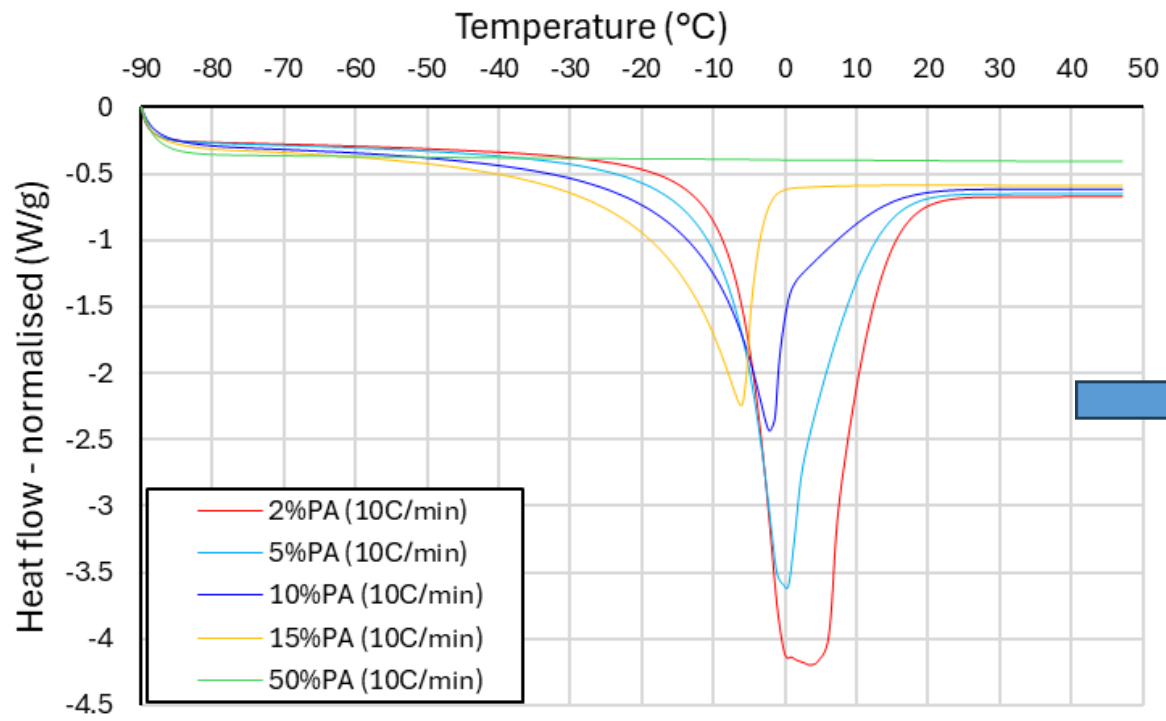
Pendulum Testing

- Used different spread rates and water film thicknesses at different temperatures to understand the effectiveness of the de-icer.
- Novel wheel tracking used to simulate trafficking.



Laboratory Testing

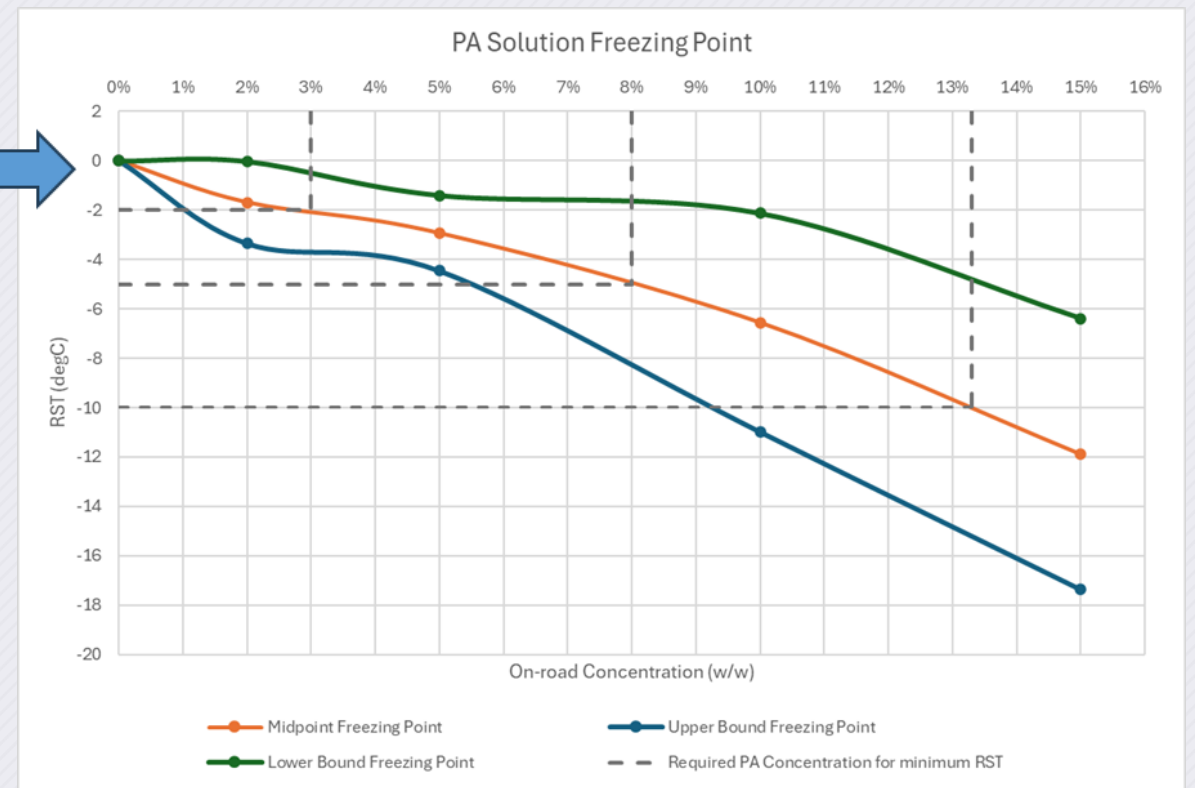
Differential Scanning Calorimetry Results



↑ Graph shows the heat flux during the potassium acetate solution phase change from solid to liquid.

Larger troughs indicate a faster change of state.

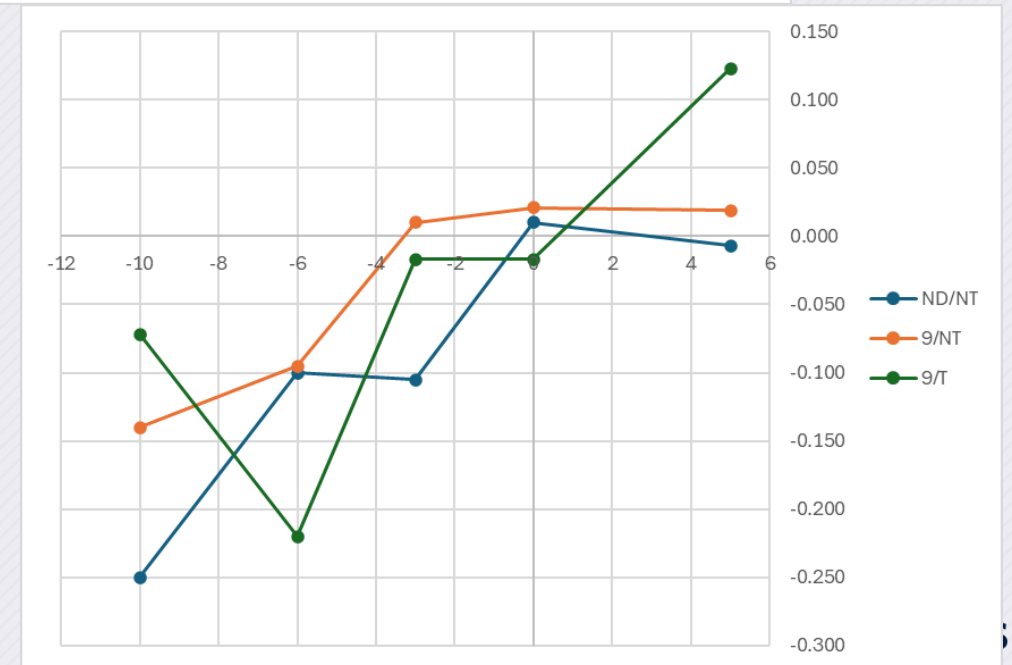
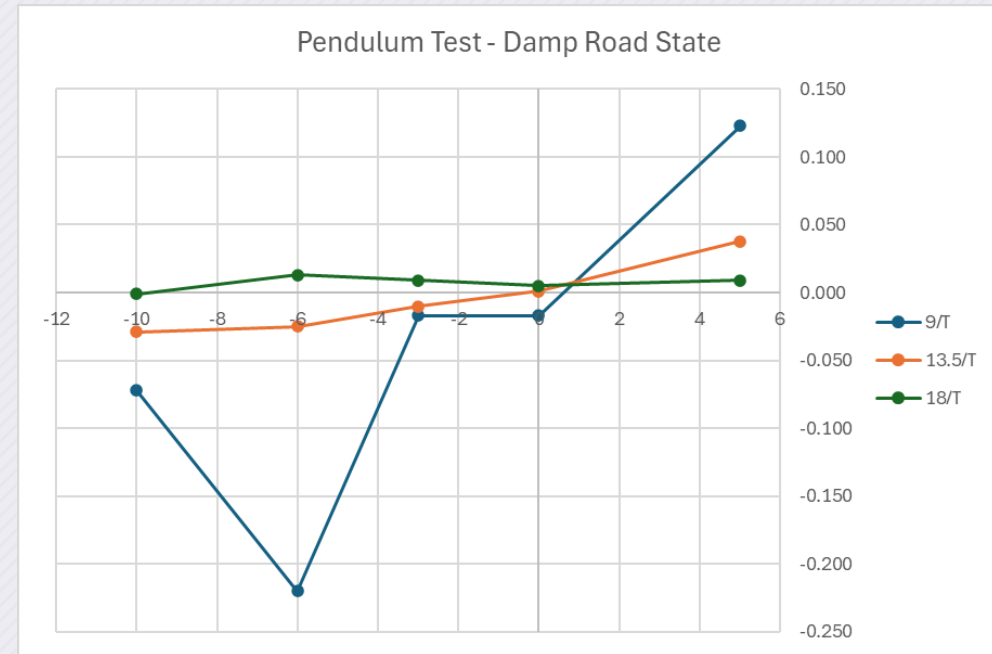
Measuring the steepest gradient of the left-hand side of the trough provides the freezing point temperature for each concentration which is plotted below ↓



Laboratory Testing

Pendulum Test Results

- Majority of testing simulated DAMP road conditions (0.05mm or 50g/m² of water)
- 9g/m² (~8% conc.) was effective at ice mitigation down to -3°C.
- 9g/m² inconsistent at lower RSTs.
- 13.5g/m² (~11% conc.) was effective at ice mitigation down to -6°C.
- Simulated trafficking improve de-icer performance



Trial Matrix

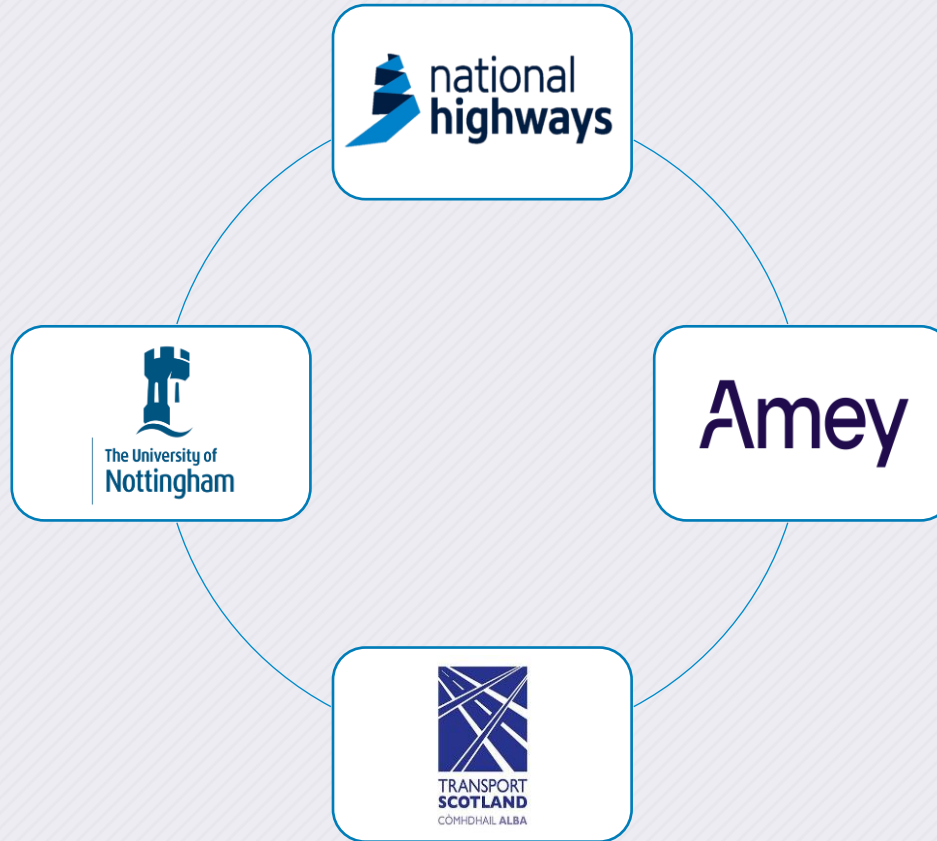
- Developed through the laboratory testing.
- On-road concentration is taking the maximum road state water film thickness (e.g. DAMP = 50g/m² // 0.05mm).
- Loss of 20-25% is taken from brine trials conducted in Scotland – would be a maximum loss and unlikely.
- Theoretical freezing point is using the concentration after this loss.

Conditions	NH Current Treatment Rate (g/m ²)	Trial Treatment Rate (g/m ²)	Minimum Concentration	Concentration Range	Litres/ Metre Square	Minimum Concentration after initial 20% loss	Theoretical Freezing Point
1. Frost or forecast frost RST at or above -2C and DRY or DAMP road condition	18	10	~8.3%	8.3-50%	0.007	~6.3%	-4 to -6C
2. Frost or forecast frost RST at or above -2C and WET road condition	18	20	~8.3%	8.3-14.3%	0.014	~6.3%	-4 to -6C
3. Frost or forecast frost RST below -2C and above -5C and DRY or DAMP road condition	18	14	~11.5%	11.5-50%	0.011	~9.2%	-6 to -10C
4. Frost or forecast frost RST below -2C and above -5C and WET road condition	18	2 x 14	~11.5%	11.5-18.5%	0.022	~9.2%	-6 to -10C

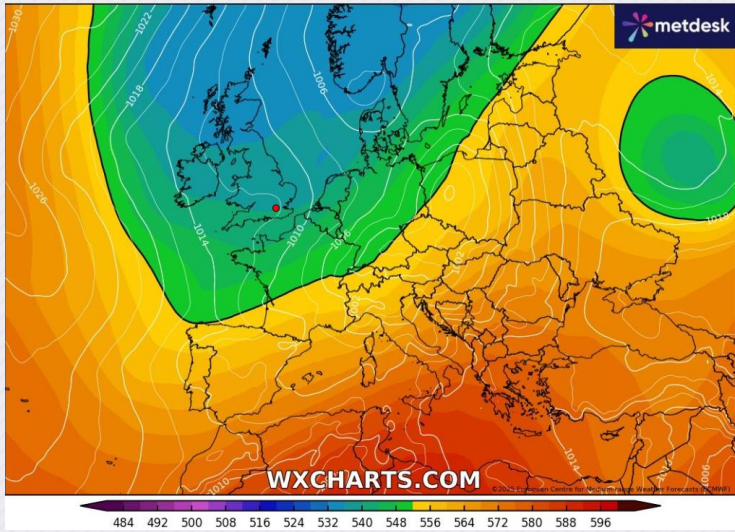
Location & Stakeholders

Erskine Bridge

- Determine existing structure treated with potassium acetate
- Operated by Amey
- Proximity to local depot & weather station
- Likelihood of cold temperatures



Forecast Review & Treatment Decision



Erskine Bridge Deck	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10	11
RST (c)	19.8	22.2	22.5	20.8	18.1	14.6	9.3	5.7	3.8	2.6	1.4	0.2	-0.8	-1.7	-2.6	-3.2	-3.5	-3.7	-3.5	-3.2	-1.2	5.9	12.7	18.2
Air Temp (c)	6.9	8.5	9.5	9.6	9.3	8.9	7.5	5.6	3.8	2.7	2.0	1.1	0.2	-0.5	-1.2	-1.7	-1.9	-2.1	-2.3	-1.7	-0.2	1.5	3.5	5.7
Weather Type	D	D	D	D	D	D	D	D	D	D	D	D	HF	HF	HF	HF	HF	HF	HF	HF	HF	D	D	D
Hoar Frost	N	N	N	N	N	N	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N
Ice	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Snow Accum. (cm)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wind Speed (mph)	9	9	9	9	9	9	8	9	8	6	5	4	4	4	3	2	2	2	2	2	2	2	2	1
Visibility (km)	21	21	24	26	24	24	22	16	19	19	20	21	21	18	15	5	14	12	12	<1	3	10	11	15
Precipitation (mm)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dew Point (C)	-1.6	-1.4	-1.1	-0.1	0.6	0.3	0.5	0.6	0.6	0.5	0.1	0.1	-0.2	-0.7	-1.3	-1.8	-2.0	-2.3	-2.4	-1.9	-0.4	0.0	0.8	1.1

2-5-day forecast

24hr forecast

Morning Forecast

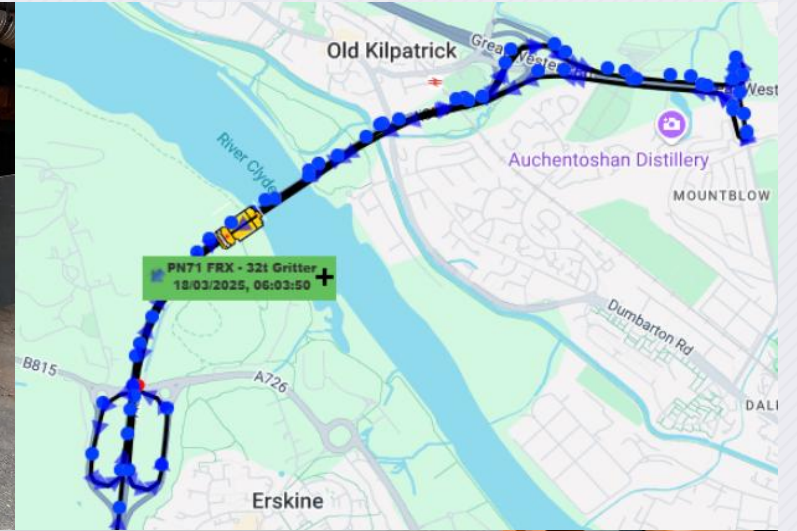
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Review and agreement dose to be applied

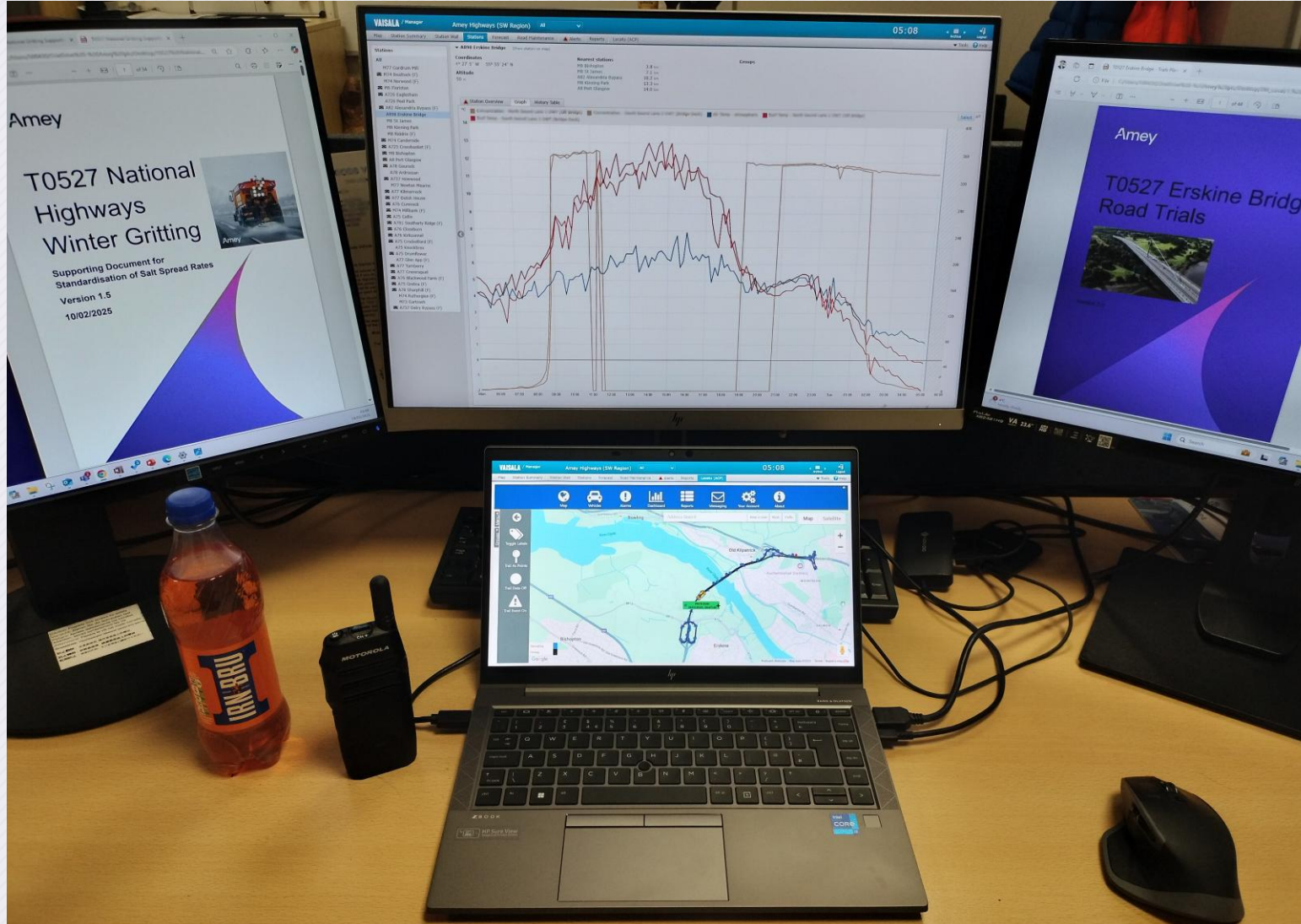


PA Treatment & Patrol Monitoring

- Specialist front line combi gritter (Spray Charles)
- Potassium acetate Treatment ~3hrs prior to forecasted freeze time
- North Bound & South Bound
- Traffic Management consideration
- Dedicated Patrol Gritter with MD30 measurement device
- Continual Lane 1 & Lane 2 patrol passes
- Additional patrol gritter datapoints captured



Trial Monitoring



Remote monitoring

Remaining within matrix temperature bounds.

Grip monitored & surface state

Erskine weather station conditions

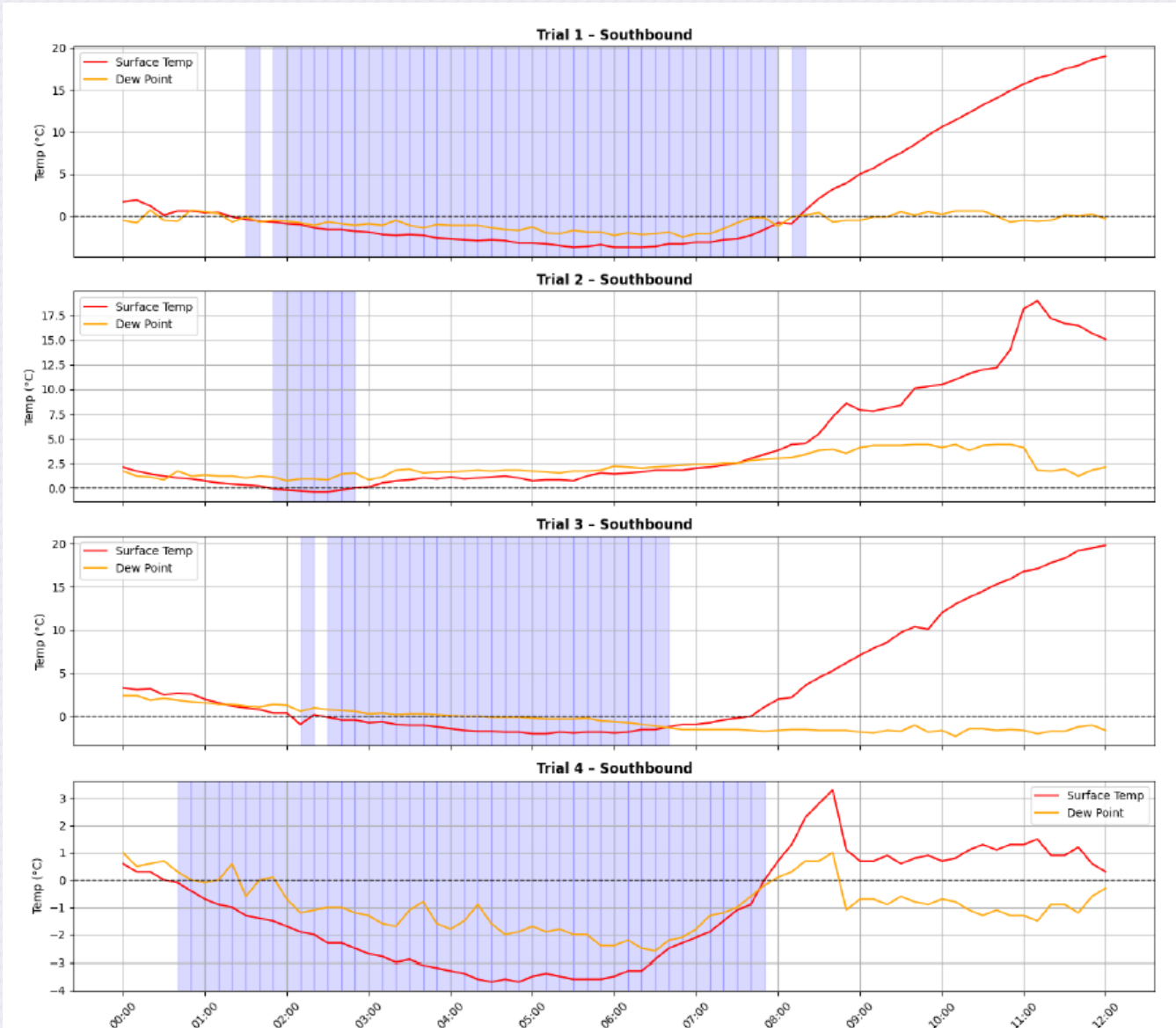
Potassium acetate Treatment & Patrol reports

North Bound & South Bound

Traffic Flow

Liaison with winter service duty officer

Road Test Results



Friday 14th March

4 Road Trials Conducted

Saturday 15th March

Monday 17th March

Tuesday 18th March

Each trial, <0 RST & Dew Point

Ice formation conditions observed

Road Test Results

Conditions observed where ice formation would be expected



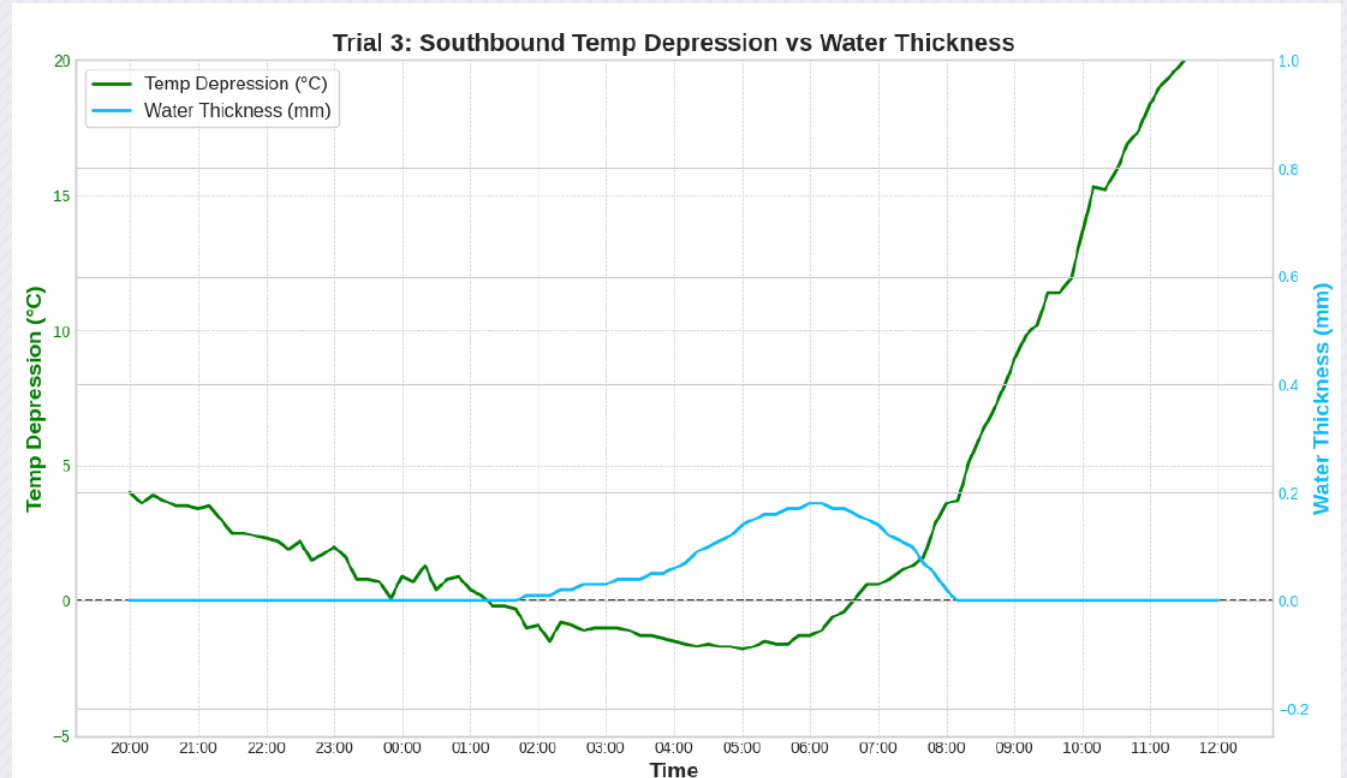
Water film thickness & <0 temperature



Surface state and grip remained constant



PA treatment prevented formation of ice during conditions in which ice formation would be expected



Benefits



Enhanced guidance and a good foundation for further work



Potential average reduction in raw material cost of 4-9% per annum



Potential carbon saving of 6.5-15.7t eCO₂ per annum



Environmental benefit by being more efficient



National Highways Wider Activity & Roadmap

Wider Activity

- **Footways, Cycleways, and Bridleways Review** – Assessing National Highways winter policy is fit for purpose; improvements that may be required from an asset management perspective; and investigating possible requirements in the future related to Active Travel.

Future Research (2026-2028)

- **Hoar Frost** – Investigating the efficacy of dry and pre-wet applications for different severities of this hazard. Ultimately attempting to build knowledge and understanding.
- **Potassium Acetate Longevity** – Building on previous work to better understand the longevity of this de-icer on the road surface.



What blockers have you faced when undertaking winter research?

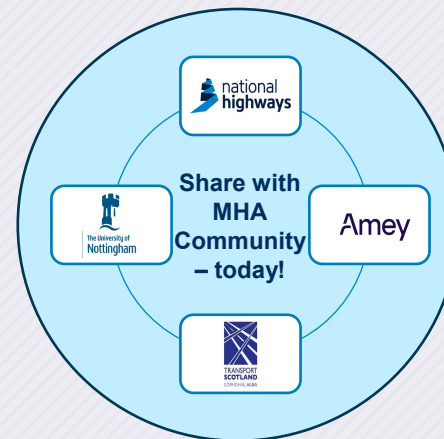
Summary of research benefits to MHA community

LHA Application:

- National Research <> LHA Application
- Art of possible
- Combined MHA community opportunity
- Best practice documentation (NWSRG)

Key Resources for consideration:

- NWSRG – Documentation eg Section Five
- PIARC – TC 3.2 Winter Service
 - UK delegation attendance & summary*
- Cold Comfort 20-21 May



Section Five

Treatment Methodologies & Technologies

Key check list:

- Have you considered alternatives to the de-icing materials you have been using to date? Cost-benefit analyses may indicate efficiency savings and lower spread rates could potentially lead to improved resilience.
- Have you considered the performance of the different spreading technologies in the weather conditions your area experiences? (See Section 5.B)

March 2019

In association with  INSTITUTE OF HIGHWAY ENGINEERS



INTEGRATION OF NEW TECHNOLOGIES IN WINTER SERVICE

A PIARC TECHNICAL REPORT
TECHNICAL COMMITTEE 3.2 WINTER SERVICE





Audience Q&A

① The Slido app must be installed on every computer you're presenting from