INNOVATIVE WINTER MAINTENANCE GUIDELINES IN AUSTRIA

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Introduction and importance of winter maintenance in Austria

- Motorways and federal highways are administrated by the ASFINAG
- Regional roads are administrated by Provincial Governments, the cities or municipalities
- Austria has about 240 service centers

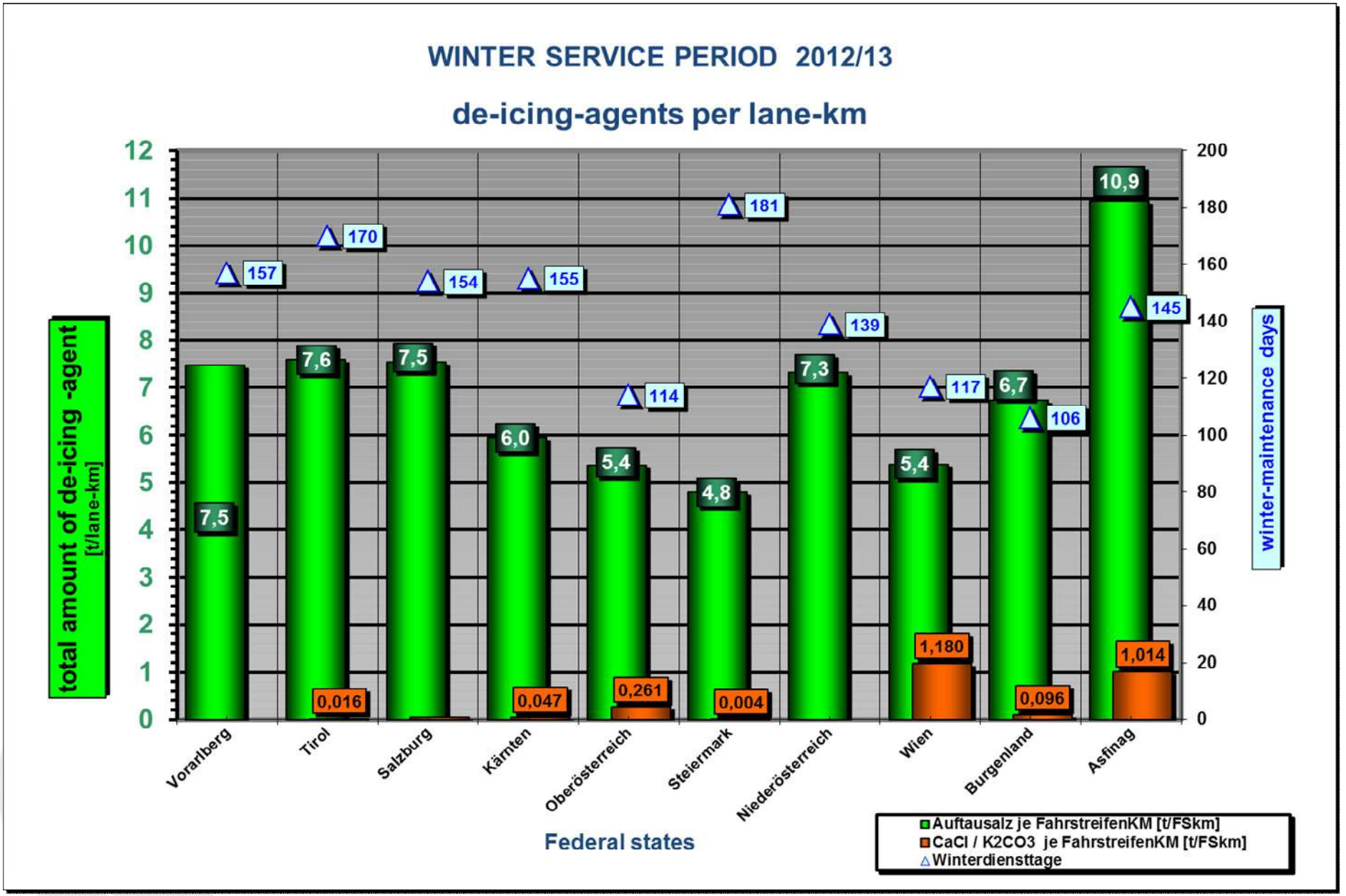
Length of the roads	
Motorways	2.185 km
Regional main roads	9.959 km
Secondary & country roads	23.680 km
Municipal roads	78.766 km
Network of public roads	**114.590 km**

Winter maintenance categories

- From the existing legal framework and standards the winter maintenance categories in Austria are:
- On highways, express roads and their junctions the maximum treatment interval (cycle time) is 3 hours in the period between 0h to 24h (**Category A**).
- At high-level country roads with AADT > 5.000 vehicles per day the maximum treatment interval is 5 hours in the period between 4h to 22h (**Category B**).
- At high-level country roads with AADT > 1.000 to 5.000 vehicles per 24 hours at the maximum treatment interval is 5 hours in the period 5h to 20h (**Category C**).
- At low-level country roads with AADT < 1.000 vehicles per day there is no maximum treatment interval in the period between 8h to 20h (**Category D**).

Winter maintenance categories on rural roads

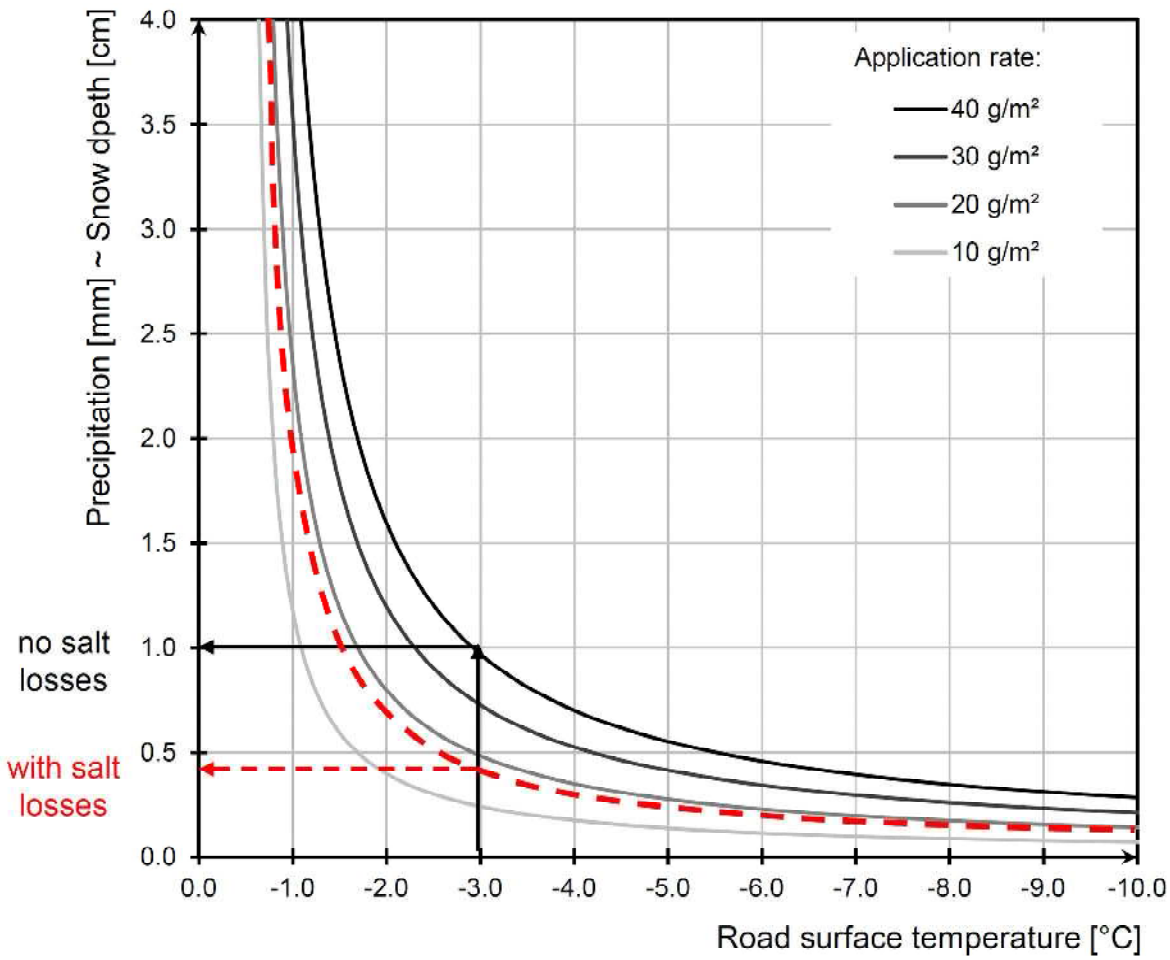
Weather situation, road condition	Category A	Category B	Category C	Category D
	Highways, Motorways and their junctions	Regional Roads with a daily traffic volume of more than 5,000	Regional Roads with a daily traffic volume between 1,000 - 5,000	Regional Roads with a daily traffic volume less than 1,000
1. Risk of hoarfrost or ice	An inspection trip per day	An inspection trip per day	An inspection trip per day	Inspection trip on demand
2. Light Snowfall, snow and ice, light snow drifts	Trafficability of all lanes, junctions and access roads to service stations. Treatment with de-icing agents - Complete clearance. Snowy road might occur	Trafficability; Treatment with de-icing agents favoured. Snow depth up to 10cm possible. Detractions between 22-6 cannot be excluded.	Trafficability; Treatment with de-icing agents or grit; Snow depth up to 10cm possible. Heavy detractions between 20-7 and on Weekend can't be excluded.	Trafficability; Treatment with grit or de-icing agents. Heavy detractions cannot be excluded.
3. Heavy Snowfall, snow drifts	Trafficability of at least one lane per direction, junctions and access roads to service stations between 0-24. Treatment with de-icing agents - Complete clearance favoured. Snowy road might occur. Trafficability of parking lots and hard shoulder not ensured. Trafficability if necessary with snow chains.	Trafficability of at least one lane per direction. Treatment with de-icing agents favoured. Heavy detractions due do snow depths of more than 10 cm possible; Trafficability if necessary with snow chains.	Trafficability of at least one lane per direction. Treatment with de-icing agents or grit. Heavy detractions due do snow depths of more than 10 cm possible; Trafficability if necessary with snow chains.	Trafficability of at least one lane if necessary with snow chains. Treatment with grit or de-icing agents. Snow clearance from snow depths of 10 cm (8 to 20 clock).
		In case of gritting - only after completion of snow removal		
4. Heavy snow drifts, avalances, extreme ice (e.g. freezing rain)	Trafficability cannot be ensured. Temporary road closures might appear. Information of road users carried by media and police.			
Winter Maintenance service time	00 - 24 Treatment intervals as required	4 - 22 Treatment intervals as required	5 - 20 Treatment intervals as required	8 - 20 Treatment intervals as required
Time of circulation	max. 3 hours	max. 5 hours	max. 5 hours	----
Annotation	Time of circulation = Time between 2 Treatments, Trafficability = Use by vehicles with winter gear possible, Heavy Snowfall = More than 10 cm in 3 hours			


WINTER SERVICE PERIOD 2012/13
de-icing-agents per lane-km
total amount of de-icing -agent [t/lane-km]
winter-maintenance days
Federal states
Vorarlberg
Tirol
Salzburg
Kärnten
Oberösterreich
Steiermark
Niederösterreich
Wien
Burgenland
Asfinag
7,5
7,6
7,5
6,0
5,4
4,8
7,3
5,4
6,7
10,9
0,016
0,047
0,261
0,004
1,180
0,096
1,014
157
170
154
155
114
181
139
117
106
145
Auftausalz je FahrstreifenKM [t/FSkm]
CaCl / K2CO3 je FahrstreifenKM [t/FSkm]
Winterdiensttage

Limited de-icing capability of sodium chloride

Freezing point

- Theoretical thawing capacity is very limited
- Salt losses reduce practical thawing capacity
- Results show initial salt losses of around 60%
- Further losses related to traffic & surface conditions



Application rates due to precipitation, temperature and traffic

Precipitation 0,0 mm to 0,25 mm - Snow hight 0,0 cm to 0,25 cm
Hoarfrost or slightly visible snowfall

Application rate [g/m²]	Road surface temperature [°C]									
	-1	-2	-3	-4	-5	-6	-7	-8	-9	-10
Traffic during interval										
250	5	16	26	36	10	10	10	10	10	10
500	6	16	27	37	10	10	10	10	10	10
1.000	6	17	28	39	10	10	10	10	10	10
1.500	6	18	30	10	10	10	10	10	10	10
2.000	6	19	31	10	10	10	10	10	10	10
2.500	7	20	33	10	10	10	10	10	10	10
3.000	7	21	35	10	10	10	10	10	10	10
3.500	8	23	37	10	10	10	10	10	10	10
4.000	8	24	40	10	10	10	10	10	10	10

Precipitation 0,25 mm to 0,5 mm - Snow hight 0,25 cm to 0,5 cm
Very light snowfall

Application rate [g/m²]	Road surface temperature [°C]									
	-1	-2	-3	-4	-5	-6	-7	-8	-9	-10
Traffic during interval										
250	11	32	10	10	10	10	10	10	10	10
500	11	33	10	10	10	10	10	10	10	10
1.000	12	34	10	10	10	10	10	10	10	10
1.500	12	36	10	10	10	10	10	10	10	10
2.000	13	38	10	10	10	10	10	10	10	10
2.500	14	10	10	10	10	10	10	10	10	10
3.000	14	10	10	10	10	10	10	10	10	10
3.500	15	10	10	10	10	10	10	10	10	10
4.000	16	10	10	10	10	10	10	10	10	10

Precipitation 0,5 mm to 0,75 mm - Snow hight 0,5 cm to 0,75 cm
Light snowfall

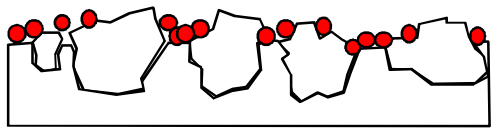
Application rate [g/m²]	Road surface temperature [°C]									
	-1	-2	-3	-4	-5	-6	-7	-8	-9	-10
Traffic during interval										
250	16	10	10	10	10	10	10	10	10	10
500	17	10	10	10	10	10	10	10	10	10
1.000	17	10	10	10	10	10	10	10	10	10
1.500	18	10	10	10	10	10	10	10	10	10
2.000	19	10	10	10	10	10	10	10	10	10
2.500	20	10	10	10	10	10	10	10	10	10
3.000	22	10	10	10	10	10	10	10	10	10
3.500	23	10	10	10	10	10	10	10	10	10
4.000	24	10	10	10	10	10	10	10	10	10

Precipitation 0,75 mm to 1,0 mm - Snow hight 0,75 cm to 1,0 cm
Light/moderate snowfall

Application rate [g/m²]	Road surface temperature [°C]									
	-1	-2	-3	-4	-5	-6	-7	-8	-9	-10
Traffic during interval										
250	22	10	10	10	10	10	10	10	10	10
500	22	10	10	10	10	10	10	10	10	10
1.000	23	10	10	10	10	10	10	10	10	10
1.500	24	10	10	10	10	10	10	10	10	10
2.000	26	10	10	10	10	10	10	10	10	10
2.500	27	10	10	10	10	10	10	10	10	10
3.000	29	10	10	10	10	10	10	10	10	10
3.500	31	10	10	10	10	10	10	10	10	10
4.000	33	10	10	10	10	10	10	10	10	10

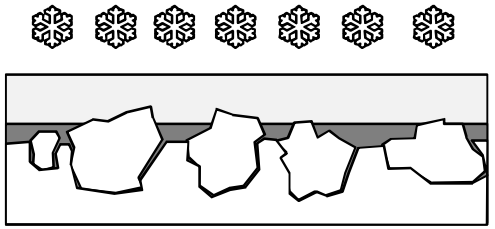
Preventive treatment

The most effective salting strategy (release coating)



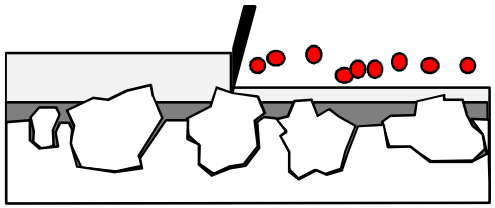
1. Preventive treatment before snowfall event

e.g. 10 g/m^2 on the eve of a snowfall event of 1 cm/h
road surface temperature = - 5°C mit treatment intervall = 3 h
resulting in 3 cm snow depth per treatment interval



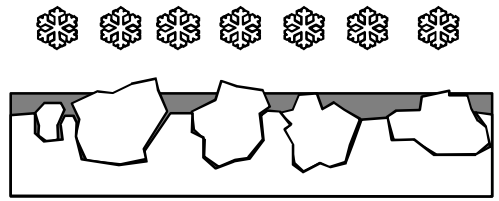
2. Dilution and formation of 2 phases

1. Phase snow/ice above (about 0% salt) density 0,1-0,9 g/cm^3
2. Phase brine below (8% salt) density 1,1 g/cm^3. The applied salt is dissolved gradually, until an equilibrium concentration is reached at 8% and -5 °C



3. Snowploughing and salt application

The brine film prevents adhesion of the snow on the road surface and relieves further snowploughing. For salt application applies: remaining snow + applied salt = brine 8%> (salt consumption depends on quality of ploughing and road condition)



4. Thaw residual snow (continue with 2)

Thaw of the remaining snow and brine formation > 8%; ongoing development according to 2 until end of snowfalls (discharge loss due to traffic and mixing not considered)

Salt Snowfall Snow/Ice Brine

Maintenance strategy & driving: Dry & wet road conditions

Picture documentation	Road conditions	Treatment recommendations	Driving recommendations
Dry Road:	**Very good (usually no problems)**	**Minimal salt application:**	**No limitation:**
	High skid resistance $\mu = 0,7 – 1,0$ Road surface temperature -30°C to + 60 °C	No treatment required	No restrictions within speed limits based on road conditions are required.
	No sleekness due to hoarfrost expected	No treatment required	The road is generally safe to use within speed limits
	Sleekness due to hoarfrost possible	Preventive Treatment 5 - 10 g/m² with beginning hoarfrost (usually between 02:00 - 04:00)	The road is usually safe after treatment (consider visibility in case of fog!)
Wet Road:	**Good (black ice possible!)**	**Treatment only at tempetrures below 0°C**	**Speed reduction nessecary:**
	Road surface temperature ≥ 0°C no spray Medium skid resistance $\mu = 0,4 - 0,7$	No treatment required	Adapted driving style
	Spray medium to low skid resistance $\mu = 0,3 - 0,6$	check lane grooves (risk of aquaplaning)	Speed restriction when lane grooves below 70 km/h (highways and regional roads)
	Road surface temperature < 0°C risk of black ice; very low skid resistance $\mu = 0,1–0,6$	Preventive treatment is crucial! Ploughing & salt application from 20 to 40 g/m² & warning messages	Risk of black ice, massive speed reduction below 30 km/h or walking pace is highly recommended

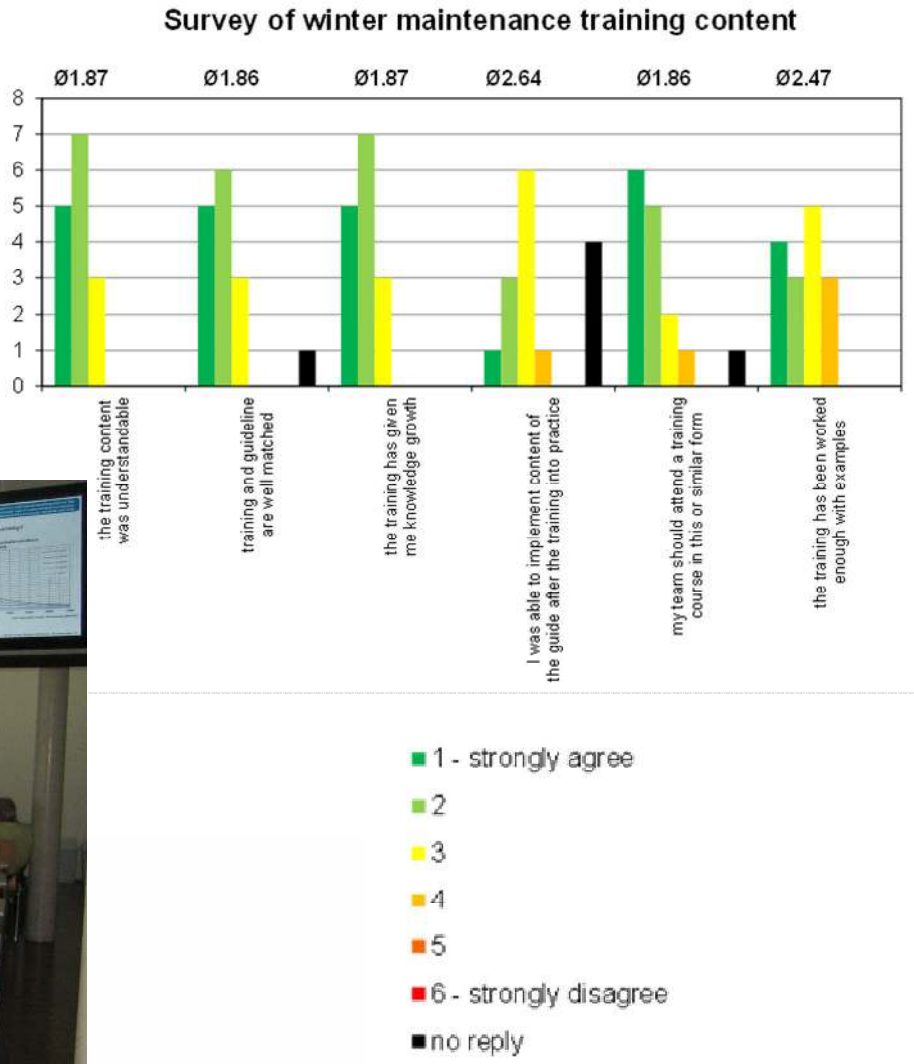
Maintenance strategy & driving: Snowing with/out snow covered road

Picture documentation	Road conditions	Treatment recommendations	Driving recommendations
Snow next to wheel tracks:	**Fair (problems when changing lanes)**	**Ploughing and salt application as required**	**Careful driving and speed reduction necessary:**
	No snowfall	Ploughing and salt application 20 - 30 g/m²	Adapted driving style. Speed reduction of 20 - 30%
	Wheel tracks dry or weg skid resistance μ = 0,3 – 0,5	Ploughing and salt application 10 - 20 g/m² when less than 0,5 cm snowfall in treatment interval	Adapted driving style. Speed reduction of 20 - 30%
	Snowfall, Snow remains in wheel tracks (grey - white surface) low skid resistance μ = 0,2 – 0,4	With snowfall > 0,5 cm ploughing & salt application of 10 g/m² until end, then 20 g/m² to 30 g/m²	Adapted driving to road conditions, reducing the speed limit by up to 50%
Snow in wheel tracks:	**Bad (very low skid resistance)**	**Ploughing and salt application as required**	**Adaptive driving and speed reduction necessary:**
	No snowfall, cleared low skid resistance μ = 0,2 - 0,3 road surface temperature ≤ 0°C	Treatment with ploughing and salt application to clear the road of snow	Reducing the speed limit below 80 km/h (highways) and below 50 km/h (regional roads)
	Snowfall, cleared, not cleared, precipitation < 0,5 mm in treatment interval (≈ 3 - 5 mm snow)	Preventive treatment prior to preciptitation event if possible, then ploughing and salt application	Reducing the speed limit below 70 km/h (highways) and below 50 km/h (regional roads) - Visibility!!
	Snow > 0,5mm in treatment interval low skid resistance μ = 0,2 - 0,3 road surface temp. -20°C to 0°C	With snowfall > 0,5 cm ploughing & salt application of 10 g/m² until end, then 20 g/m² to 30 g/m²	Reducing the speed limit below 50 km/h (highway) and below 30 km/h (regional roads) - Visibility!!

Maintenance strategy & driving: Ice covered road

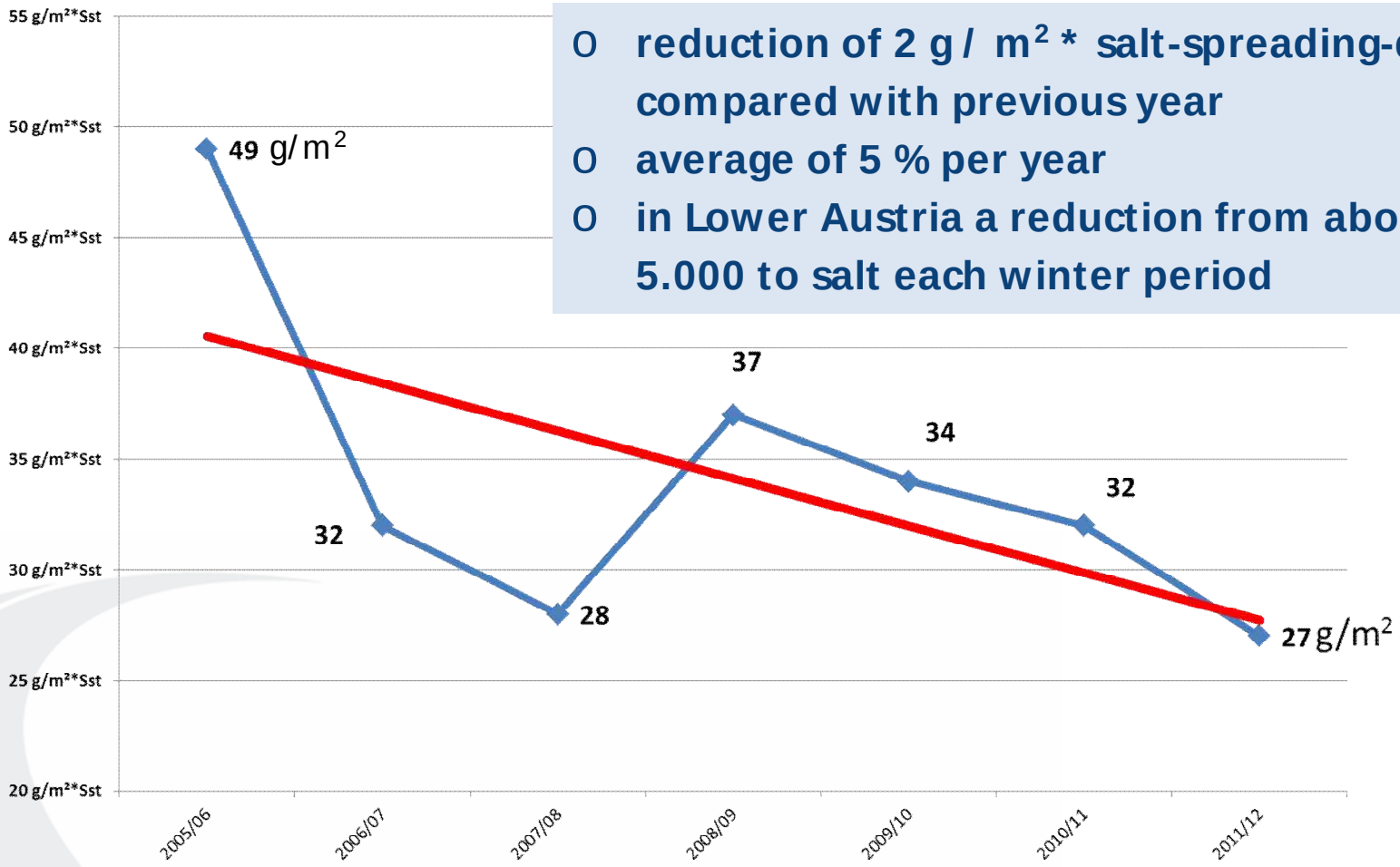
Picture documentation	Road conditions	Treatment recommendations	Driving recommendations
Black ice:	**Critical (almost no skid resistance)**	**Mechanical removal & maximum salt application, closing of roads:**	**Driving restrictions (walking pace may be allowed)**
	No precipitation Roadway surface satin silk to reflective Almost no skid resistance μ=0,1–0,2 Precipitation (Snow) Road surface temperature $\leq$ 0°C	Preventive treatment if possible, maximum salt application at icy parts. Staggered treatment. Closing of roads only in consultation with the police, then mechanical removal combined with maximum salting to remove the ice. Best strategy to avoid accidents is to close the roads until a sufficient skid resistance is reached again.	Possible driving restrictions have to be considered. Postpone unnecessary trips. During a trip continue in exceptional cases and reduce velocity on potentially dangerous parts to walking pace.

Training and feedback of the staff



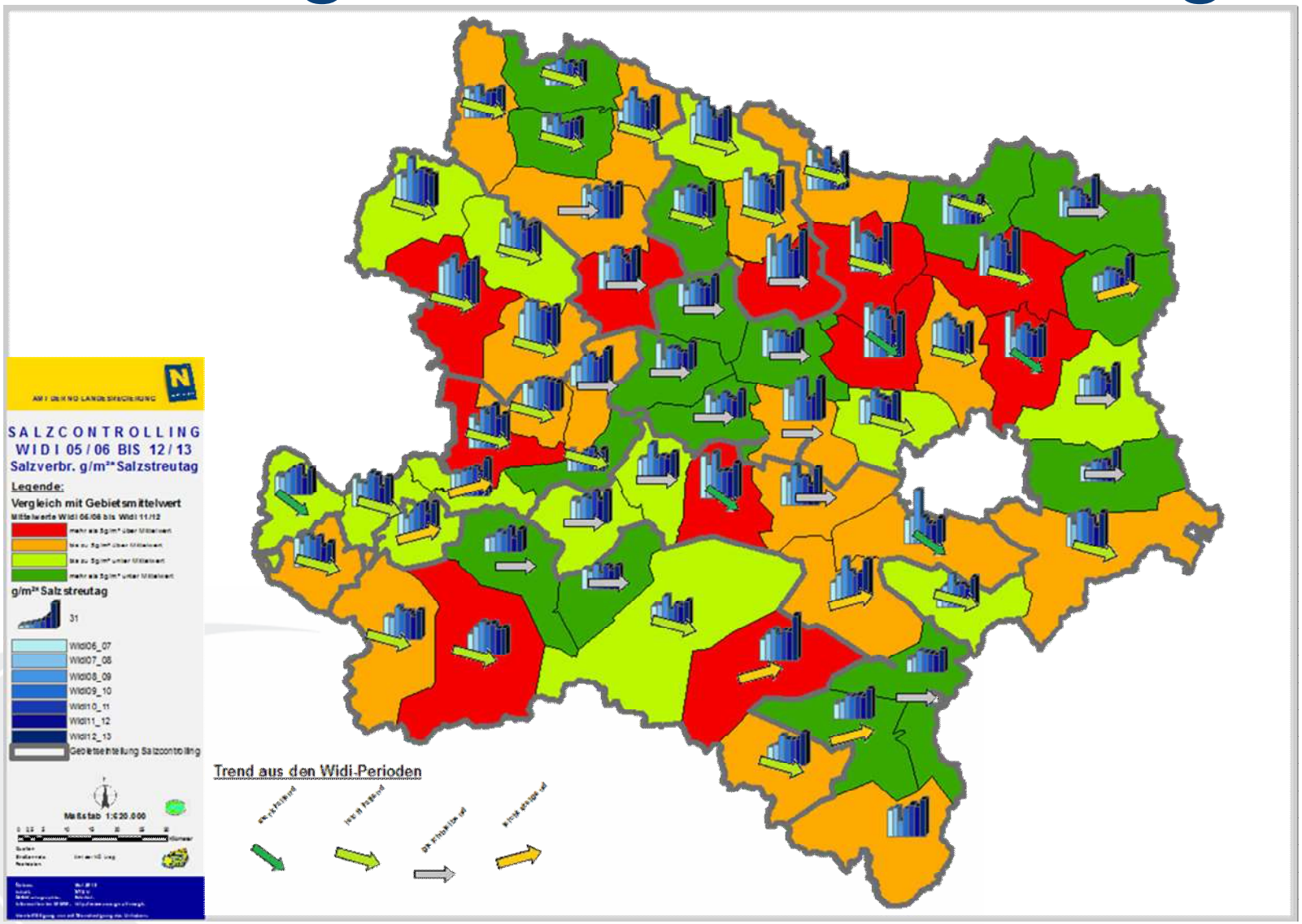
Savings and salt-controlling

salt-consumption g/m² and salt-spreading-day



- reduction of 2 g / m² * salt-spreading-day, compared with previous year
- average of 5 % per year
- in Lower Austria a reduction from about 5.000 to salt each winter period

Savings and salt-controlling



Conclusions of the research and outlook

- **The minimum scattering quantity is 5 g / m², less is ineffective and uneconomical due to the equipment & personnel costs.**
- **The spreading runs are put in time so, that the route has been scattered sufficiently before the beginning of a precipitation event (approx. 5 - 10 g / m² preventive spreading max. 1 - 2 h before precipitation).**
- **With salt only limited amounts of snow can be thawed. If the snowfall amount over (> 0.5 cm / hour), the road can not be kept with the available scattering quantities and rides free of snow.**
- **In these cases, with a low spread rate 10-15 g / m², a freezing of the snow on the road surface can be prevented. The later removal is facilitated.**
- **Winter maintenance cannot guarantee a snow- or ice-free road all the time, careful driving and a reduction of the speed compared to the actual speed limits are required.**

Publication of research

download from the homepage of the BM VIT (Federal M inistry of Transport, Innovation and Technology);

www.bmvit.gv.at

http://www.bmvit.gv.at/service/publikationen/verkehr/strasse/downloads/feuchtsalzstreuung.pdf

THANK YOU FOR YOUR ATTENTION

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