Alaska Department of Transportation & Public Facilities

Research & Technology Transfer

Corrosion Concerns in Alaska to Personal and Commercial Vehicles caused by Chlorides used in Winter Operations

Prepared by:

Laura Fay, Karalyn Clouser, and Neil Hetherington
Western Transportation Institute – Montana State University
PO Box 174250
Bozeman, MT 59717

January 2025

Prepared for:
Alaska Department of Transportation & Public Facilities
Statewide Research Office
3132 Channel Drive
Juneau, AK 99801-7898

Publication Number

REPORT DOCUMENTATION PAGE

Form approved OMB No.

1. AGENCY USE ONLY (LEAVE BLANK)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
FHWA-AK-RD-000S(945)	January 14, 2025	Final Report (October 2023 – December 2024)

4. TITLE AND SUBTITLE
Corrosion Concerns in Alaska to Personal and Commercial Vehicles caused by Chlorides used in Winter Operations and how to manage through use of Best Management Practices

5. FUNDING NUMBERS
State HFHWY00223
Federal 000S(945)

6. AUTHOR(S)
Laura Fay, Karalyn Clouser, and Neil Hetherington

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Western Transportation Institute
Montana State University
PO Box 174250
Bozeman, MT 59717

8. PERFORMING ORGANIZATION REPORT NUMBER
4WA620

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
State of Alaska, Alaska Dept. of Transportation and Public Facilities
Research and Technology Transfer
3132 Channel Drive
Juneau, AK 99801-7898

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
FHWA-AK-RD-000S(945)

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION / AVAILABILITY STATEMENT
No restrictions

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

The objective of this research effort was to synthesize relevant information on corrosion to Department of Transportation (DOT) equipment and vehicles caused by chloride-based deicing materials used in the state of Alaska. To accomplish this, a survey of Alaska Department of Transportation and Public Facilities (AKDOT & PF) personnel was used to identify deicers used and corrosion concerns. A literature review was conducted, and a synthesis document was developed that identified common corrosion issues and best management practices (BMPs) that can be used to prevent and or reduce corrosion. Fact sheets were developed to share information on corrosion concerns and BMPs that can be used to prevent and or reduce corrosion for both AKDOT & PF and the public. Identified best practices include using corrosion inhibitors in deicing products, washing equipment and vehicles as frequently as is feasible, following washing applying barrier protection when feasible, and conducting routine inspections of equipment and vehicles to report and initiate repairs of corrosion related damage.

14- KEYWORDS : Corrosion, best management practices, vehicle wash, corrosion inhibitors, barrier protection, fact sheet

15. NUMBER OF PAGES
72

16. PRICE CODE
N/A

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	N/A

Notice

This document is disseminated under the sponsorship of the U.S. Department of Transportation in the interest of information exchange. The U.S. Government assumes no liability for the use of the information contained in this document. The U.S. Government does not endorse products or manufacturers. Trademarks or manufacturers' names appear in this report only because they are considered essential to the objective of the document.

Quality Assurance Statement

The Federal Highway Administration (FHWA) provides high-quality information to serve Government, industry, and the public in a manner that promotes public understanding. Standards and policies are used to ensure and maximize the quality, objectivity, utility, and integrity of its information. FHWA periodically reviews quality issues and adjusts its programs and processes to ensure continuous quality improvement.

Author's Disclaimer

Opinions and conclusions expressed or implied in the report are those of the author. They are not necessarily those of the Alaska DOT&PF or funding agencies.

METRIC (SI*) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4		mm
ft	feet	0.3048		m
yd	yards	0.914		m
mi	Miles (statute)	1.61		km
		AREA		
in^2	square inches	645.2	millimeters squared	cm^2
ft^2	square feet	0.0929	meters squared	m^2
yd^2	square yards	0.836	meters squared	m^2
mi^2	square miles	2.59	kilometers squared	km^2
ac	acres	0.4046	hectares	ha
		MASS (weight)		
oz	Ounces (avdp)	28.35	grams	g
lb	Pounds (avdp)	0.454	kilograms	kg
T	Short tons (2000 lb)	0.907	megagrams	mg
		VOLUME		
fl oz	fluid ounces (US)	29.57	milliliters	mL
gal	Gallons (liq)	3.785	liters	liters
ft^3	cubic feet	0.0283	meters cubed	m^3
yd^3	cubic yards	0.765	meters cubed	m^3

Note: Volumes greater than 1000 L shall be shown in m^3

		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (°F-32)	Celsius temperature	°C
		ILLUMINATION		
fc	Foot-candles	10.76	lux	lx
fl	foot-lamberts	3.426	candela/m^2	cd/cm^2
		FORCE and PRESSURE or STRESS		
lbf	pound-force	4.45	newtons	N
psi	pound-force per square inch	6.89	kilopascals	kPa

These factors conform to the requirement of FHWA Order 5190.1A *SI is the symbol for the International System of Measurements

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	Miles (statute)	mi
		AREA		
mm^2	millimeters squared	0.0016	square inches	in^2
m^2	meters squared	10.764	square feet	ft^2
km^2	kilometers squared	0.39	square miles	mi^2
ha	hectares (10,000 m^2)	2.471	acres	ac
		MASS (weight)		
g	grams	0.0353	Ounces (avdp)	oz
kg	kilograms	2.205	Pounds (avdp)	lb
mg	megagrams (1000 kg)	1.103	short tons	T
		VOLUME		
mL	milliliters	0.034	fluid ounces (US)	fl oz
liters	liters	0.264	Gallons (liq)	gal
m^3	meters cubed	35.315	cubic feet	ft^3
m^3	meters cubed	1.308	cubic yards	yd^3

		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 °C+32	Fahrenheit temperature	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/cm^2	candela/m^2	0.2919	foot-lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	pound-force	lbf
kPa	kilopascals	0.145	pound-force per square inch	psi

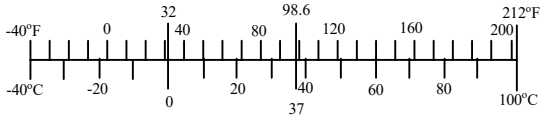

Table of Contents

List of Tables

List of Figures

Acknowledgements

This research report herein was performed for the Alaska Department of Transportation and Public Facilities (AKDOT & PF) by the Western Transportation Institute at Montana State University (WTI-MSU), which was contracted for this study. Laura Fay, Senior Research Scientist, was the principal investigator. The other authors include Karalyn Clouser a Research Associate at WTI-MSU and Neil Hetherington a Visual Communications specialist at WTI-MSU. Editorial review was provided by Dana May, Director of Communications.

The research team would like to thank AKDOT & PF staff for participating in the survey and the Project Panel for their input and guidance.

This page intentionally left blank

Executive Summary

The objective of this research effort was to synthesize relevant information on corrosion to Department of Transportation (DOT) equipment and vehicles caused by chloride-based deicing materials used in the state of Alaska. To accomplish this, a survey of Alaska Department of Transportation and Public Facilities (AKDOT & PF) personnel was used to identify deicers used and corrosion concerns. A literature review was conducted, and a synthesis document was developed that identified common corrosion issues and best management practices (BMPs) that can be used to prevent and or reduce corrosion. Fact sheets were developed to share information on corrosion concerns and BMPs that can be used to prevent and or reduce corrosion for both AKDOT & PF and the public. A summary of the survey results and synthesis document are provided herein.

Survey Summary

A survey of maintenance districts at the AKDOT & PF identified a wide range of deicing products used on roadways, including state highways, secondary and local roads, unpaved roads, and pedestrian paths. Deicers used are generalized as:

- Sodium Chloride (NaCl)
- Calcium Chloride ($CaCl_2$)
- Magnesium Chloride ($MgCl_2$)
- Sodium Chloride/Sand Mix (salt-sand)
- Sodium Chloride Mixed with Calcium Chloride Brine and Corrosion Inhibitor
- Rock Salt Mixed with Corrosion Inhibitor

The predominant use of solid or liquid deicers varies regionally across the state based on preference, with the Central and Northern Regions using more solids, and the Southcoast Region using more liquids while also using solids. Only a few districts in each region indicated that they use pre-wetting.

Application rate ranges for these products were as follows:

- Solids: >200–440 pounds per lane mile (lbs/l-m) depending on conditions
- Liquids: 20–70 gallons per lane mile (gal/l-m) depending on temperatures (above 22°F) and conditions

At AKDOT & PF there are concerns about corrosion with observed corrosion occurring to the following vehicle and equipment components:

- Truck frames, rails
- Chassis mounts, under chassis components

- Brake components
- Wheel rims
- Air valves
- Wiring, wiring harness connectors, electrical components
- Sensors
- Suspension components
- Sanders
- Liquid tanks
- Plows
- Underbody plows/scrapers
- Wing plows
- Cast aluminum, non-marine grade aluminums, sheet metal, pot metal objects, steel components

Current actions taken by AKDOT & PF to prevent corrosion include washing vehicles, using a corrosion inhibitor with the deicer, using a salt neutralizer, and using under coatings and spray films on equipment. The use of these practices varies by district.

Summary of Synthesis on Corrosion Concerns and BMPs

Corrosion can occur in many different forms and chloride-based deicers are known to cause corrosion to equipment, vehicles, and infrastructure. Corrosion caused by chloride-based deicers can cost state DOTs $1 million to $14 million per year. These costs are attributed to corrosion damage to equipment and vehicles, early replacement of parts, equipment downtime, reduced reliability, reduced equipment service life, and increased safety risks from faulty or corroded parts. Personal vehicle costs for rust repairs were estimated at $630 per vehicle.

Best practices to prevent or reduce corrosion caused by chloride-based deicers includes using anti-corrosion coatings, washing equipment and vehicles regularly, using salt neutralizer during washing, using corrosion inhibitors in deicers, and modifying equipment and vehicle designs to reduce corrosion trouble spots. Using these BMPs to prevent or reduce corrosion has been found to increase service life and reduce costs associated with corrosion by up to 20%, while paring training with the overall use of proactive BMPs to prevent corrosion can reduce agency-wide corrosion issues by 30%.

CHAPTER 1: INTRODUCTION AND RESEARCH APPROACH

Problem Statement and Research Objectives

The objective of this research effort was to synthesize relevant information on corrosion to DOT equipment and vehicles caused by chloride-based deicing materials used in the state of Alaska. Specifically, information is provided on which deicers are used, the type of corrosion caused, and best management practices (BMPs) that have been shown to prevent or reduce corrosion.

Scope of Study

The scope of this study includes deicer-related corrosion concerns to DOT vehicles and equipment, commercial vehicles, and personal vehicles in the state of Alaska. It also includes the BMPs that can be used to prevent or reduce corrosion damage.

Research Approach

To capture this information, a survey of AKDOT & PF personnel was used to identify deicers used, corrosion concerns, and BMPs already in place in the state of Alaska. Then a detailed literature search was conducted to find information on corrosion types, corrosion concerns, corrosion costs, and information on BMPs available for corrosion prevention and reduction.

Methodology

Survey

A survey developed for AKDOT & PF personnel was conducted to identify deicers used, corrosion concerns, and BMPs already in place in Alaska. The survey questionnaire was reviewed by the Project Panel members and MSU's Institutional Research Board prior to dissemination. The survey was sent out via email as Word and PDF files. Survey responses were received via email, compiled, and the Survey Results were developed. The survey was sent out October 2023, and survey responses were submitted through March 2024. The survey questionnaire can be found in APPENDIX A: SURVEY INSTRUMENT.

Literature Search

A literature search was conducted that focused on corrosion to vehicles and DOT equipment caused by chloride-based deicers. Information was sought on corrosion types, corrosion costs, and methods to prevent or reduce corrosion damage. The following databases were used to gather relevant information: Google Scholar, Transportation Research Information Service, ISI Web of Science, and Montana State University Library. The literature search also included documents published by state DOTs, Clear Roads,

University Transportation Centers (UTCs), the Strategic Highway Research Program (SHRP), Federal Highway Administration (FHWA), National Cooperative Highway Research Program (NCHRP), PIARC (World Road Association), American Public Works Association (APWA), and American Association of State Highway and Transportation Officials (AASHTO).

Fact Sheets

Using information gathered in the survey and literature search, two fact sheets were developed—one for AKDOT & PF personnel and one for the driving public. The fact sheets provide information on known corrosion issues caused by chloride-based deicers and methods that can be implemented to prevent or reduce corrosion to DOT equipment and personal vehicles.

CHAPTER 2: FINDINGS

Survey Results

This survey received a total of 28 responses from AK DOT & PF regions across the state of Alaska (Figure 1 and Table 1).

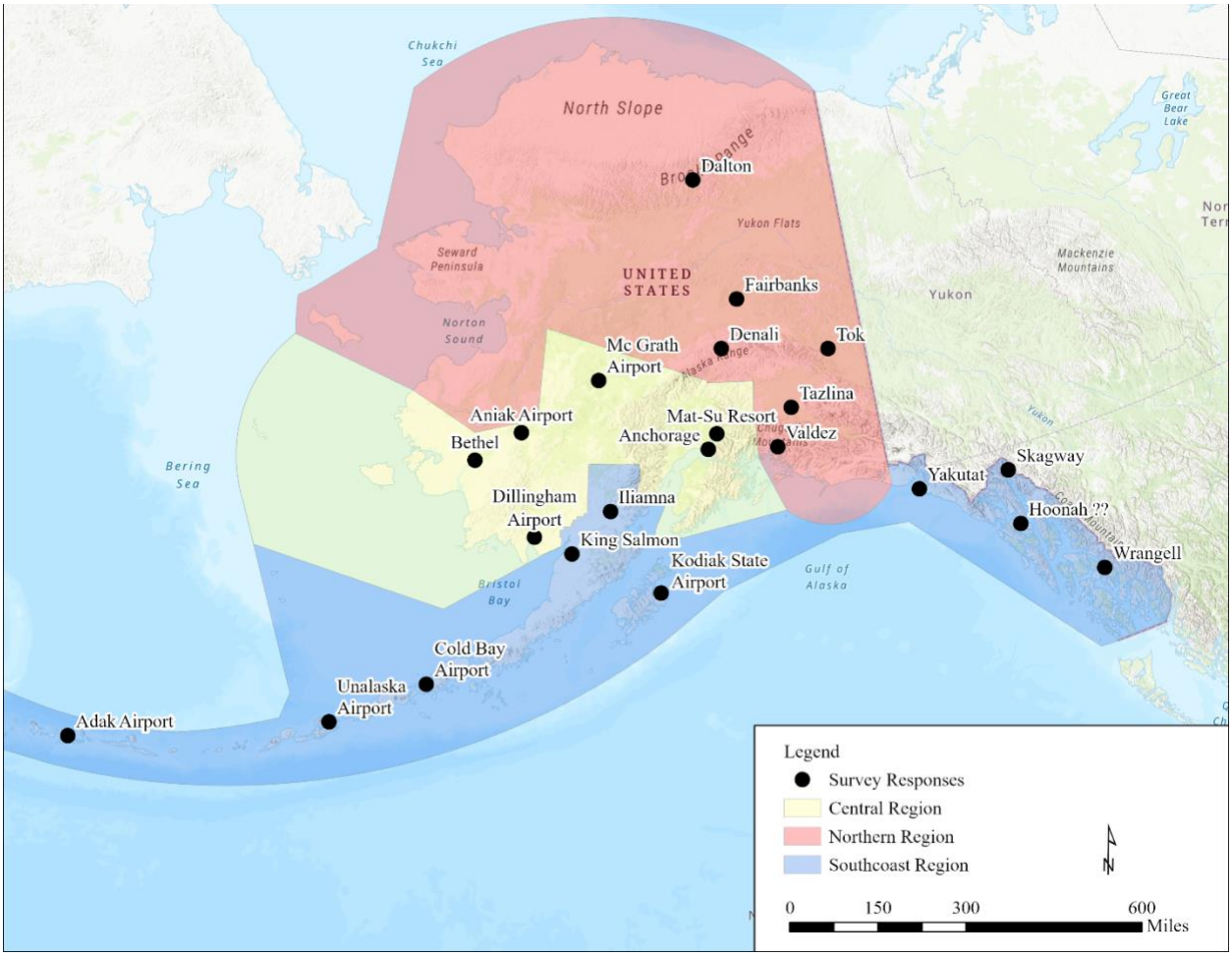

Figure 1. Survey Response Locations

Table 1. Survey Response Details

Name	Job Title	Location	AKDOT Region	AKDOT Maintenance District
Kayce Eliason	Anchorage District Superintendent	Central Region	Central	Anchorage
Kyler Hylton	Matsu District Superintendent, Maintenance & Operations	Central Region	Central	Mat-Su

Name	Job Title	Location	AKDOT Region	AKDOT Maintenance District
Steffen Strick	Operator	McGrath Airport	Central	Mat-Su
Joe Larank	Airport Manager	Bethel	Central	Southwest
Jon Taylor	Dillingham Station Foreman	Central Region, SW District	Central	Southwest
Roxanne Evan	Aniak Manager	Southwest	Central	Southwest
William "Jeff" Russell	Dalton Area Superintendent	Northern Region	Northern	Dalton
Jason Ludington	Denali Superintendent	Northern	Northern	Denali
Ron Davis	Fairbanks District Superintendent	Northern Region	Northern	Fairbanks
Chad Heller	Maintenance Supervisor	Northern Region Tazlina District	Northern	Tazlina
Samuel Jennings	M&O Superintendent	Northern Region, Tok District	Northern	Tok
Robert Dunning	Valdez District Superintendent	Northern	Northern	Valdez
Calvin Schaeffer	Western District M&O Superintendent	Northern	Northern	Western
Clint Anelon	Airport Manager	Kodiak Aleutian Chain District, Iliamna	Southcoast	Kodiak/Aleutian Chain
Dale Ruckman	Unalaska Airport Manager	Southcoast	Southcoast	Kodiak/Aleutian Chain
Innocent Dushkin	Airport Manager	Southcoast; Adak Airport	Southcoast	Kodiak/Aleutian Chain
Floyd Wilson	Airport Foreman	Southcoast; King Salmon	Southcoast	Kodiak/Aleutian Chain
Phil Smith	Rural Airport Foreman, Kodiak State Airport	Southcoast Region, Kodiak/Aleutian District	Southcoast	Kodiak/Aleutian Chain
Shaun McKnight	Foreman 1/Rural Airport Manager	Southcoast Skagway	Southcoast	Southeast
Barry Youngberg	Foreman	Southeast	Southcoast	Southeast
Doug Carl	Operator	Southeast	Southcoast	Southeast

Name	Job Title	Location	AKDOT Region	AKDOT Maintenance District
Matthew Boron	Haines Foreman	Southeast	Southcoast	Southeast
Robert Lekanof Jr	Airport Manager	Yakutat Station	Southcoast	Southeast
Herold L. Kremer III (Hap)	Airport Manager	SCR	Southcoast	
Adam McLavey	Foreman	Southcoast	Southcoast	
Gary Allen	Airport Foreman	Southcoast	Southcoast	
Kenneth Meserve	Station Foreman	Southcoast	Southcoast	
Richard Asplund	Foreman II	Southcoast	Southcoast	

Products Used

Respondents were asked to provide details on which deicing and anti-icing products, additives, and dust-control products their maintenance region uses on the following facilities: DOT roads, paved local roads, unpaved local roads, pedestrian facilities, and airports. They were also asked to provide details on products used by private landowners (if known).

DOT Roads

The following deicing, anti-icing, and dust-control products were identified as those used on DOT roads (Table 2):

- Sodium Chloride (NaCl)
- Calcium Chloride ($CaCl_2$)
- Magnesium Chloride ($MgCl_2$)
- Sodium Chloride/Sand Mix
- 3-5% salt blended with 3/8" Minus Sand Mix
- Hot Sand (25% Salt, 75% Sand)
- Sodium Chloride Mixed with RoadGuard +8 (Calcium Chloride Brine with 8% Corrosion Inhibitor)
- CG-90 Salt with Anti-Corrosion (Rock Salt Mixed with Corrosion Inhibitor)
- Rock Salt with Rust Inhibitor (Inhibitor CG-90, Ice Slicer)
- Salt Brine/Boost (Calcium Chloride)

The Central Region of Alaska primarily uses solid and liquid sodium chloride and a sodium chloride/sand mix to treat DOT roads. The Anchorage Maintenance District reported that they occasionally mix calcium chloride brine into their sodium chloride (however, this was done rarely). Both calcium chloride and magnesium chloride are being used for dust control in the Central Region.

The Northern Region of Alaska reports using sodium chloride and a sodium chloride/sand mix (typically, at 3–5% salt-to-sand).

The Fairbanks Maintenance District reports using salt brine mixed with RoadGuard +8, which is a calcium chloride brine with an 8% corrosion inhibitor. The Fairbanks Maintenance District also notes using hot sand.

The Dalton and Fairbanks Maintenance Districts report using calcium chloride for summer maintenance and dust control.

The Southcoast Region reported using sodium chloride, sodium chloride and sand mix, magnesium chloride, and calcium chloride.

Table 2. Products Used on DOT roads with survey respondent comments.

AKDOT Region	AKDOT Maintenance District	Deicers, Anti icers, Dust Control for DOT Roads
Central	Anchorage	**Sodium Chloride**. In **brine and solid** form mainly mixed with sand. We mix according to weather [one] batch at a time in a pit to soak it. On **occasion** we mix **Calcium chloride brine into our sodium chloride**. This is rarely done. **Magnesium Chloride very sparingly for spring dust control in sensitive areas.**
Central	Mat-Su	N/A—no deicers used on DOT roads in Matsu District. We use a **salt/sand mixture**.
Central	Southwest	**Sodium Chloride** **Calcium Chloride**
Central	Southwest	**Sodium Chloride** both **solid and liquid** for deicing. **Calcium Chloride solid** for **dust control**.
Northern	Dalton	**Dust control** product—**calcium chloride** (varies from 3 bags to 8 bags per mile) each bag weighs 2400 lbs. If figured by volume effective blending is 2" x 30' x 1 mile x 8 cubic yards

AKDOT Region	AKDOT Maintenance District	Deicers, Anti icers, Dust Control for DOT Roads
Northern	Denali	**Solid road salt**
Northern	Fairbanks	**Sodium chloride, Sodium chloride brine, Sodium chloride brine with RoadGuard +8** (typically, 80% NaCl, 20% RoadGuard), **hot sand** (75% sand, 25% sodium chloride blend) Summer Maintenance: **Calcium chloride (dust control)** on DOT gravel roads
Northern	Tazlina	We use **sand mixed with 5% salt**.
Northern	Tok	**Sodium Chloride**
Northern	Valdez	**Salt Brine and Salt added to sand at 3%**
Northern	Western	**3-5% salt blended with 3/8" minus sand mixture**
Southcoast	Kodiak/Aleutian Chain	**Salt, Calcium Chloride**, DOT has both paved and unpaved roads
Southcoast	Kodiak/Aleutian Chain	**Sand/Salt Mix**
Southcoast	Kodiak/Aleutian Chain	**Salt Brine**, @23.3%, 40 gal/lane mile, and **pre-wet sand**
Southcoast	Southeast	We use **premixed sand** for all surfaces except airport. The rate of use is 500yds **sand** with 30,000 lbs **salt** and 16,000 lbs **calcium chloride**.
Southcoast	Southeast	**Mag Chloride**
Southcoast	Southeast	**Liquid MgCl**
Southcoast	Southeast	**CG-90 salt with anti-corrosion**
Southcoast		**Sand, Sodium Chloride 100%, Magnesium Chloride 100%**
Southcoast		**Mag[nesium chloride]**
Southcoast		**Rock salt solid with rust inhibitor**. In years past it has been CG-90, ice slicer I am not sure what it is called now.
Southcoast		**Salt Brine/Boost**

Local Roads (Paved and Unpaved)

Similar products are used to treat paved local roads (Table 3). Identified deicers include:

- Sodium Chloride (NaCl)
- Magnesium Chloride ($MgCl_2$)
- Sodium Chloride/Sand Mix
- 3-5% salt blended with 3/8" Minus Sand Mix

Treatments identified for unpaved local roads are:

- Sodium Chloride (NaCl)
- Magnesium Chloride ($MgCl_2$)
- Calcium Chloride ($CaCl_2$)

Table 3. Products used on local roads with survey respondent comments.

AKDOT Region	AKDOT Maintenance District	Deicers, Anti icers, Dust Control for Local Roads (Paved)	Deicers, Anti icers, Dust Control for Local Roads (Unpaved)
Central	Anchorage	Municipal uses **Mag Chloride in intersections** and **mixes sodium chloride in sand stockpile in Eagle River suburb**. **Mag[nesium chloride] is also used for dust control in spring very sparingly.**	Municipal use **Mag Chloride in intersections and mixes sodium chloride in sand stockpile in Eagle River suburb**
Central	Mat-Su		**Calcium Chloride pellets (dust control) summertime**
Northern	Dalton	None used	None
Northern	Denali	**Solid road salt**	**Solid road salt, sodium calcium chloride** (brand depends on who gets the low bid)
Northern	Tazlina	We use **sand with 5% salt**.	
Northern	Tok	**Sodium Chloride**	**Calcium Chloride for dust control**
Northern	Valdez	**Salt Brine and Salt added to sand at 3%**	**Salt Brine and Salt added to sand at 3%**
Northern	Western	**3-5% salt blended with 3/8" minus sand mixture**	**3-5% salt blended with 3/8" minus sand mixture**
Southcoast	Kodiak/Aleutian Chain	**Salt Brine**, @23.3%, 40 gal/lane mile, and **pre-wet sand**	Only chemicals we put on gravel roads is **calcium chloride** @ about 1 ton/lane mile
Southcoast	Southeast	See Above (We use **premixed sand** for all surfaces except airport. The rate of use is 500yds **sand** with 30,000 lbs **salt** and 16,000 lbs **calcium chloride**.)	
Southcoast	Southeast	**Liquid MgCl**	
Southcoast		**Mag[nesium chloride]**	

Pedestrian Facilities

Few respondents identified deicers utilized on pedestrian facilities. For those that did, sodium chloride and sand were used (Table 4).

Table 4. Products used on pedestrian facilities with survey respondent comments.

AKDOT Region	AKDOT Maintenance District	Deicers, Anti icers, Dust Control for Pedestrian Facilities
Central	Anchorage	Don't know what product they use.
Northern	Dalton	None
Northern	Fairbanks	**Sidewalk deicer** (Chinook Ultra Plus Ice Melt, Alaska Garden and Pet) **or sodium chloride**
Northern	Valdez	**Salt Brine and Salt added to sand at 3%**
Northern	Western	**3-5% salt/3/8" minus sand mixture**
Southcoast	Kodiak/Aleutian Chain	**Dry Sand**
Southcoast	Kodiak/Aleutian Chain	**Rock salt**, spread by hand, unknown application rate

Airports

Urea was the most commonly reported deicer used at airports across the state of Alaska (Table 5). Identified airport deicers include:

- Urea
- New Deal (Sodium Acetate/Sodium Formate Blend)
- New Deal (Sodium Acetate/Sodium Formate Blend) and Urea Mixed with Sand
- E-36 (Potassium Acetate)
- Potassium Acetate
- Sand

Table 5. Products used at airports with survey respondent comments.

AKDOT Region	AKDOT Maintenance District	Deicers, Anti icers, Dust Control for Airports
Central	Anchorage	None for Anchorage.
Central	Mat-Su	**Prilled urea**
Central	Mat-Su	**New Deal and Urea mixed with sand**
Central	Southwest	**Potassium Acetate "E-36"** **"New Deal" Sodium Acetate/Sodium Formate Blend**

AKDOT Region	AKDOT Maintenance District	Deicers, Anti icers, Dust Control for Airports
Central	Southwest	**Potassium Acetate liquid for deicing.** **Urea both solid and liquid for deicing**.
Central	Southwest	**Solid Urea**
Northern	Dalton	**Potassium Acetate and Sodium Acetate/Formate Blend** (New Deal) as needed
Northern	Tazlina	No deicer/Anti-icer used
Northern	Valdez	**Urea solid and liquid potassium acetate**
Northern	Western	**Potassium Acetate liquid and New Deal deicer blend**
Southcoast	Kodiak/Aleutian Chain	**New Deal, Urea**
Southcoast	Kodiak/Aleutian Chain	**Urea, E36**
Southcoast	Kodiak/Aleutian Chain	**Urea, Solid**
Southcoast	Kodiak/Aleutian Chain	**Sand, E-36 (Potassium Acetate), New Deal**
Southcoast	Kodiak/Aleutian Chain	**New Deal Deicing, Sodium Formate mix**, 1–2 gal per linear ft. and pre-wet sand mixed @2200 per 800 gal
Southcoast	Southeast	We use a **pre-mixed sand** 500 yards with 50,000 lbs of **urea pellets**.
Southcoast	Southeast	**Urea**
Southcoast	Southeast	**Solid Urea**
Southcoast	Southeast	**Urea - both solid and liquid**
Southcoast		**Urea Solid/Urea Brine**
Southcoast		**New Deal**
Southcoast		Only **sand**

Private Landowners

None of the respondents provided information on deicer products utilized by private landowners.

Deicer Use

Both the Northern and Central Regions primarily utilize solid deicers, followed by liquids (around half of the respondents from these regions; Table 6). The Southcoast Region primarily uses liquid deicers (73% of respondents), followed by solids (53%).

Only one respondent reported "Other." This Anchorage respondent noted that they "mix sand and sodium chloride brine in a pit prior to loading in sanders." This is a method of pre-wetting sand.

Table 6. Deicer Type Used

AKDOT Region	AKDOT Maintenance District	Solid	Pre Wet Solid	Liquid	Other
Central	Anchorage	x	x	x	x
Central	Mat-Su	x			
Central	Mat-Su	x			
Central	Southwest	x		x	
Central	Southwest	x		x	
Central	Southwest	x			
Total Central	**6 Respondents**	**6 (100%)**	**1 (17%)**	**3 (50%)**	**1 (17%)**
Northern	Dalton	x		x	
Northern	Denali	x			
Northern	Fairbanks	x	x	x	
Northern	Tazlina	x			
Northern	Tok	x			
Northern	Valdez	x	x	x	
Northern	Western	x		x	
Total Northern	**7 Respondents**	**7 (100%)**	**2 (29%)**	**4 (57%)**	**0 (0%)**
Southcoast	Kodiak/Aleutian Chain	x			
Southcoast	Kodiak/Aleutian Chain	x		x	
Southcoast	Kodiak/Aleutian Chain	x		x	
Southcoast	Kodiak/Aleutian Chain	x			
Southcoast	Kodiak/Aleutian Chain	x	x	x	
Southcoast	Southeast			x	
Southcoast	Southeast			x	
Southcoast	Southeast			x	
Southcoast	Southeast	x		x	
Southcoast	Southeast				
Southcoast				x	
Southcoast				x	
Southcoast		x		x	
Southcoast		x			
Southcoast				x	
Total Southcoast	**15 Respondents**	**8 (53%)**	**1 (7%)**	**11 (73%)**	**0 (0%)**

Application Rate

Respondents were asked to provide details on their application rates and responses were divided based on roadway application rates (Table 7) and airport application rates (Table 8).

Roadway Application Rates

Application rates varied based on product used, temperature, condition, and location.

For AKDOT & PF regions utilizing salt brine, application rates of 20–70 gallons per lane mile (gal/l-m) are common, though the Southcoast Region noted that they do not use salt brine at temperatures under 22 °F. The Northern Region (Fairbanks) noted that a rate of 20–70 gal/l-m is used for anti-icing. The Southern Region noted that they only use solid salt as a backup to brine and only in high traffic areas. In the Anchorage Maintenance District, respondents noted that they rarely spread solid salt but when they do it is at an application rate of 0.3–0.5 yards per lane mile (≥ 200 pounds per lane mile [lbs/l-m]).

Salt is often mixed with sand at a ratio of 3–20% salt to 80–97% sand with the Northern and Central Regions utilizing ratios with more salt.

Application rates for salt/sand mix vary from 0.5–2 yards per lane mile or 200–440 lbs/l-m under normal winter conditions (described by the Northern Region as 4" of snow at below freezing temperatures) to upwards of 1,300 lbs/l-m during a rain/ice event. One respondent from the Southcoast Region noted they use a rock salt with a rust inhibitor, and that one 2,500 pound bag will cover all their roads.

For magnesium chloride (noted in the Southcoast Region only), application rates range from 6-25 gal/l-m.

Airport Application Rates

Urea application rates range 1–3 tons per 150' x 6,400' of application coverage.

Those using New Deal (Sodium Acetate/Sodium Formate Blend) use application rates ranging from 293–586 lbs/l-m in the Central Region (Southwest). The Northern Region noted using 3,000–6,000 gallons at both the airport in Nome and in Kotzebue or 0.2 gallons per square yard of E36 (PA). The Southcoast Region (Kodiak/Aleutian Chain) reported using New Deal with the truck operating at 20 miles per hour with the shoot set at 3 inches.

Potassium Acetate (liquid) is used at an application rate of 300–900 gallons per use.

Table 7. Deicer, Anti-icer, Dust Control Application Rates on Roads and Pedestrian Facilities.

AKDOT Region	AKDOT Maintenance District	DOT Roads	Local Roads (Paved)	Local Roads (Unpaved)	Pedestrian Facilities	Application Rate Roads and Pedestrian Facilities
Central	Anchorage	Sodium Chloride. In brine and solid form mainly mixed with sand. We mix according to weather batch at a time in a pit to soak it. On occasion we mix Calcium chloride brine into our sodium chloride. This is rarely done. Magnesium Chloride very sparingly for spring dust control in sensitive areas.	Municipal uses Mag Chloride in intersections and mixes sodium chloride in sand stockpile in Eagle River suburb. Mag is also used for dust control in spring very sparingly.	Municipal use Mag Chloride in intersections and mixes sodium chloride in sand stockpile in Eagle River suburb	Don't know what product they use.	.5 to 2 yards per lane mile. We rarely spread straight salt but if we do it's .3 to .5 yards per lane mile. We sand hill curves and rut rough roads. If conditions needed it, we apply to straightaways.
Central	Southwest	Sodium Chloride Calcium Chloride				20% sodium chloride/80% sand mix: 2 cu per mile Calcium chloride: 4 tons per lane mile
Central	Southwest	Sodium Chloride both solid and liquid for deicing. Calcium Chloride solid for dust control.				Calcium Chloride: 2 tons per centerline mile. Sodium Chloride: Varies per the application speed and whether we are pre-wetting roads or slushing compact snow and ice.
Northern	Denali	Solid road salt	Solid road salt	Solid road salt, sodium calcium chloride (brand depends on who gets the low bid)		Nenana 10% salt to sand Healy 15% salt to salt Cantwell 10% salt to sand.

AKDOT Region	AKDOT Maintenance District	DOT Roads	Local Roads (Paved)	Local Roads (Unpaved)	Pedestrian Facilities	Application Rate Roads and Pedestrian Facilities
Northern	Fairbanks	Sodium chloride, Sodium chloride brine, Sodium chloride brine with RoadGuard +8 (typically 80%-20% blend), hot sand (75% sand – 25% sodium chloride blend) Summer Maintenance: Calcium chloride (dust control) on DOT gravel roads			Sidewalk deicer (Chinook Ultra Plus Ice Melt, Alaska Garden and Pet) or sodium chloride	It definitely varies by temperature, condition, location, and application. For pre-wet, we typically use approximately 75-100 gallons per 11 ton load (6-9 gal/ton), and that applies to sand, salt, or our hot sand blend. For anti-icing, we apply at 20-70 gallons per lane mile.
Northern	Tazlina	We use sand mixed with 5% salt.	We use sand with 5% salt.			During a rain/ice event we may use as much as 1,300 pounds of sand per lane mile. Under normal winter conditions (such as 4" of snow at below freezing temps) we would average 200 pounds of sand per lane mile. And that would include a heavier application at driveways, intersections, and hills. And lighter or no application on strait flat sections of road.
Northern	Tok	Sodium Chloride	Sodium Chloride	Calcium Chloride for dust control		3-5 % salt mixed into our winter maintenance sand.
Northern	Valdez	Salt Brine and Salt added to sand at 3%	Salt Brine and Salt added to sand at 3%	Salt Brine and Salt added to sand at 3%	Salt Brine and Salt added to sand at 3%	Salt Brine is applied at 40 gallon per lane mile, sand with salt is applied at 440 pounds per lane mile.

AKDOT Region	AKDOT Maintenance District	DOT Roads	Local Roads (Paved)	Local Roads (Unpaved)	Pedestrian Facilities	Application Rate Roads and Pedestrian Facilities
Northern	Western	3-5% salt blended with 3/8" minus sand mixture	3-5% salt blended with 3/8" minus sand mixture	3-5% salt blended with 3/8" minus sand mixture	3-5% salt blended with 3/8" minus sand mixture	Varies by storm or weather event. No more than 3-4 yards per day on most occasions of sand.
Southcoast	Kodiak/Aleutian Chain	Salt, Calcium Chloride, DOT has both paved and unpaved roads!				Roads 30LM we use 2 bags of salt. Same rate application - 30% spinner.
Southcoast	Kodiak/Aleutian Chain	Sand/Salt Mix			Dry Sand	Mack Truck E-36 liquid is preset.
Southcoast	Kodiak/Aleutian Chain	Salt Brine, @23.3%, 40 gal/lane mile, and pre-wet sand	Salt Brine, @23.3%, 40 gal/lane mile, and pre-wet sand	Only chemicals we put on gravel roads is calcium chloride @ about 1 ton/lane mile	Rock salt, spread by hand, unknown application rate	Salt Brine @ about 40 gal/lane mile, not used with temps under about 22°. Pre-wet sand @ about 2-3gal/lane mile, used in all temps generally. Rock salt, low setting on truck. Unknown application rate. Note: Rock salt is only used as a back up to brine and only in high traffic areas.
Southcoast	Southeast	Liquid MgCl	Liquid MgCl			Average of 25 gallons/lane mile
Southcoast	Southeast	Mag Chloride				10 gallons per lane mile
Southcoast	Southeast	We use premixed sand for all surfaces except airports. The rate of use is 500yds sand with 30,000 lbs salt and 16,000 lbs calcium chloride.	See Above			1 cubic yard per mile normally More if conditions require up to 2cy/mile

AKDOT Region	AKDOT Maintenance District	DOT Roads	Local Roads (Paved)	Local Roads (Unpaved)	Pedestrian Facilities	Application Rate Roads and Pedestrian Facilities
Southcoast	Southeast	CG-90 salt with anti-corrosion				500 lbs CG-90 solid per mile. 3 tons in liquid mix (1500 gallons) @ 75' x 7800'
Southcoast		Rock salt solid with rust inhibitor. In years past it has been CG-90, Ice Slicer				Each time chemicals are needed we use one 2500 lbs bag will cover all our roads.
Southcoast		Mag[nesium Chloride]	Mag[nesium Chloride]			6 gallons per lane mile on mag.
Southcoast						Brine 12 on the specific gravity gauge or 1.18 - for urea use

Table 8. Application Rate Used at Airports.

AKDOT Region	AKDOT Maintenance District	Airports	Application Rate Airports
Central	Mat-Su	New Deal and Urea mixed with sand	1-2 tons for roadway 100' x 6,000'
Central	Southwest	Potassium Acetate "E-36" "New Deal" Sodium Acetate/Sodium Formate Blend	Potassium Acetate: 2 gallons per 1000 ft (heavy), 1 gallon per 1000 ft (light) New Deal: 293 lbs per lane mile (light), 586 per lane mile (heavy)
Central	Southwest	Solid Urea	freezing rain or icing conditions, 314 lbs per lane mile
Central	Southwest	Potassium Acetate liquid for deicing. Urea both solid and liquid for deicing.	Liquid Urea and Potassium Acetate: 1-1.5 gallons per 1,000 square feet. Solid Urea 1-3 tons per application coverage of 6,400 x 150 feet.
Northern	Western	Potassium Acetate liquid and New Deal deicer blend	Runway deicer liquid application is 300-900 gallons per use. Usually use 3-6 thousand gallons at each airport in Nome and Kotzebue.
Southcoast	Kodiak/Aleutian Chain	Urea, E36	1000 gallons per 4,500 ft
Southcoast	Kodiak/Aleutian Chain	New Deal, Urea	3 bags of New Deal, going 15 MPH at 30% spinner rate, does 9.880 ft for both runways and taxiways and ramp.
Southcoast	Kodiak/Aleutian Chain	Sand, E-36 (Potassium Acetate), New Deal	Airport sand we drive 15 MPH with the shoot set at 2 inches, New Deal truck 20 MPH with the shoot set at 3 inches
Southcoast	Kodiak/Aleutian Chain	New Deal Deicing, Sodium Formate mix, 1-2 gal per linear ft. and pre-wet sand mixed @2200 per 800 gal	Sodium Formate @ 1 to 2 gal per linear foot, not used under 15o generally.
Southcoast	Southeast	We use a pre-mixed sand 500 yards with 50,000 lbs of urea pellets.	1 cubic yard per mile normally. More if conditions require up to 2cy/mile
Southcoast	Southeast	Urea—both solid and liquid	2 tons solid urea 75' x 7800'

AKDOT Region	AKDOT Maintenance District	Airports	Application Rate Airports
Southcoast		Only sand	Each time chemicals are needed we use one 2500 lbs bag will cover all our roads.
Southcoast		New Deal	New Deal on runway depends on conditions.
Southcoast		Urea Solid/Urea Brine	Brine 12 on the specific gravity gauge or 1.18 - for urea use

Use Conditions

Respondents were asked to provide details on the conditions under which they use various products and whether there are specific locations where certain products are used. Results were separated based on whether the locations were roads (Table 9) or airports (

Table 10).

Roadway Use Conditions

For the Central Region, the Anchorage District uses a sand/brine mix for the majority of their applications (95%). The Southwest District uses potassium acetate, a sodium acetate/sodium formate blend, and sodium chloride for snow and ice control (12 °F to 40 °F). Calcium chloride is used for dust control. Products are used on hills, bridges, curves, intersections, and poor pavement conditions.

In the Northern Region, the Denali District treats the roadway when temperatures are warm enough and utilizes [rock] chips when it is too cold for salt. The Fairbanks District rarely uses solid sodium chloride except to melt ice when the temperature and oncoming weather allows. Sodium chloride is utilized in their hot sand and salt brine or salt brine with RoadGuard +8 is used to pre-treat before a storm in specific areas. The Valdez District similarly uses brine to pre-treat roadways before a storm when conditions allow. Otherwise, they use sand when it is icy. Hills, corners, and intersections were commonly noted as locations where treatment occurs. The Fairbanks District notes that, due to limited resources, they will only apply product at intersections, bridge decks, hills, curves, railroad crossings, and school crossings.

In the Southcoast Region, the Kodiak/Aleutian Chain District reports treating the roadways during freezing rain and icy conditions. Liquids are used for anti-icing and deicing when snow is not forecasted; chlorides are used at temperatures around 22 °F and sodium formate is used around 15 °F. Calcium chloride is also used in the summer for dust suppression. Shade areas, curves, bridges, hills, intersections, and crash areas are noted as areas treated with salt brine.

However, one respondent noted that all paved roads are treated when temperatures go from below to above 32 °F.

The Southeast District notes that they treat roadways during freezing temperatures or close to freezing temperatures, ice, snow, and any time traction is questionable and before major temperatures drops. One respondent noted concentration treatments to areas where drive control loss is higher (i.e., corners, steep grades, bridge decks, high traffic intersections).

Table 9. Use Conditions on Roads and Pedestrian Facilities.

AKDOT Region	AKDOT Maintenance District	Under what conditions do you use each product?	Are there specific locations for certain products?
Central	Anchorage	Sand brine mix 90% of our applications. Sand, brine, and added salt 5% of our applications. Brine out of a tanker 4% of our applications. Straight salt 1% of our applications.	Hills, bridges, curves, poor pavement conditions, intersections.
Central	Mat-Su	During and after each snow/ice event	Bridges and intersections
Central	Southwest	Icing conditions for potassium acetate, (sodium acetate/sodium formate blend), sodium chloride dust control - calcium chloride	
Central	Southwest	Snow and ice control for sodium chloride, potassium acetate, and urea. (12 °F to 40 °F) Dust control for calcium chloride.	Hills, corners, intersections, common choke points for sodium chloride.
Northern	Denali	When temps are warm enough. We use [rock] chips when it's too cold for salt.	Corners, hills, and intersections
Northern	Fairbanks	Solid (sodium chloride) – used sparingly as a standalone product. We only use it to melt ice when temperatures and follow-on weather allow or when rain is tapering off and temps are forecasted to drop. We use solid more predominantly in our hot sand and will prewet it if there is	Yes. Due to limited resources, we only apply sand, solid deicer, liquid, or blends at intersections, bridge decks, hills, curves, railroad crossings, and school crossings.

AKDOT Region	AKDOT Maintenance District	Under what conditions do you use each product?	Are there specific locations for certain products?
		not enough moisture to activate it on the ground. Pre-wet solid (sodium chloride) – see above Liquid – (salt brine or salt brine with RoadGuard +8) – used to pre-treat specific areas before a storm	
Northern	Tazlina	During and after any event that creates an icy or slippery surface.	Hills, corners, speed reduction areas, intersections.
Northern	Tok	Sand/salt mix to 15 °F. Dry sand is used below 15 °F	Bridges, hills, curves
Northern	Valdez	We pre-treat before a storm with brine and during when condition warrant it. Sand is used when it's icy.	No
Northern	Western	Usually only during snow and ice events that require it for slippery conditions.	Highways and intersections as needed.
Southcoast	Kodiak/Aleutian Chain	Freezing rain, warmer temperature from being cold like 0 °F to 40 °F.	Salt and sand for roads
Southcoast	Kodiak/Aleutian Chain	When ice is in the forecast or in the morning when we get on to shift	No
Southcoast	Kodiak/Aleutian Chain	Pre-wet for dry icy conditions, brines and liquid deicer for anti-ice and deicing when snow is not forecasted in the near future and temps about 22 °F for chlorides, and temps about 15 °F for sodium formate.	Shade areas, curves, bridges, hills and intersections, and crash areas for salt brine on the road. Sometimes when conditions go from under 32 °F to above, all paved roads are treated. We never treat gravel except

AKDOT Region	AKDOT Maintenance District	Under what conditions do you use each product?	Are there specific locations for certain products?
			calcium chloride in summer for dust.
Southcoast	Southeast	As an anti and deicer	All DOT roads
Southcoast	Southeast	Freezing conditions	No
Southcoast	Southeast	Overall icing conditions. Also use product as a pre-wet on the sanders to help sand stick to the road.	Concentrate on areas where driver control loss is highest. Corners, steeper grades, bridge decks, high traffic intersections, etc.
Southcoast	Southeast	CG90 for ice, compact snow and ice.	No
Southcoast	Southeast	Any time traction is questionable and before major temperatures drop, i.e. going from rain to freezing conditions to slow the formation of black ice.	No but we may apply more on those areas.
Southcoast		Freezing temps or close to freezing temps	No real specific locations. If it's around 38ºF we lay our deicers down.
Southcoast		Freezing, frost, snow	No
Southcoast		We use most of our chemicals as a pre-snow event, at other times when needed depending on existing conditions and forecast.	We only get rock salt solid. We generally cover intersections, hills and stop signs with an extra pass of coverage.
Southcoast		32 degrees F to 18 degrees F, Snow and ice	

Airport Use Conditions

Airports are treated with deicers and anti-icers to maintain a usable runway for aircraft. Temperatures noted for treatments range from 0 °F to 40 °F (New Deal) and 12 °F to 40 °F (Urea). The Kodiak/Aleutian Chain District noted that they treat the runway with urea only if the surface is still slick after plowing, scraping, and brooming and that they only use enough to

allow a plane to get in and out and only if the sun is not going to warm the surface enough to be wet instead of slick.

Table 10. Use Conditions at Airports.

AKDOT Region	AKDOT Maintenance District	Under what conditions do you use each product?	Are there specific locations for certain products?
Central	Mat-Su	20 °F to 35 °F	Airport
Central	Southwest	Snow and ice control for sodium chloride, potassium acetate, and urea. (12 °F to 40 °F) Dust control for calcium chloride.	Runway, taxiways, and paved apron for urea and potassium acetate.
Central	Southwest	Urea - icing conditions	Full length of runway
Northern	Dalton	Wind, temps, and what kind of moisture (rain, fog, wet snow, dry snow, and mist)	runways and taxiways
Northern	Western	Usually only during snow and ice events that require it for slippery conditions.	Runways as needed to maintain a usable surface for aircraft.
Southcoast	Kodiak/Aleutian Chain	Freezing rain, warmer temperature from being cold like 0 °F to 40 °F.	New Deal for airports
Southcoast	Kodiak/Aleutian Chain	Airport only, when icy	
Southcoast	Kodiak/Aleutian Chain	After cleaning the runway by plowing, scraping and brooming, apply urea if the surface is still slick. We use only enough to allow the plane to get in and out and only if the sun is not going to warm the surface enough to be wet instead of slick.	Airport only
Southcoast	Kodiak/Aleutian Chain	Pre-wet for dry icy conditions, brines and liquid deicer for anti-ice and deicing when snow is not forecasted in the near future and temps about 22 °F for chlorides, and temps about 15 °F for sodium formate.	All airport surfaces for sodium formate.
Southcoast	Southeast	Urea liquid: pretreat runway surface - deice - break down compact snow and ice during runway surface temp no lower than 26 °F. Urea solid: pretreat runway	No

AKDOT Region	AKDOT Maintenance District	Under what conditions do you use each product?	Are there specific locations for certain products?
		before wet conditions after a cold spell. Break down ice buildup and compact snow and ice.	
Southcoast	Southeast	Any time traction is questionable and before major temperatures drops, i.e. going from rain to freezing conditions to slow the formation of black ice.	No but we may apply more on those areas.
Southcoast		Icy	Runway only

Additional Details on Deicer Use

Respondents were then asked to provide any additional details to explain the reasoning behind their approach to roadway treatments (Table 11). The Anchorage District (Central Region) reported that they are under an MS4 permit so all materials are stored in a shed and small batches of product are mixed as needed prior to loading into a sander. This helps improve control over material use and minimize the impact of salt on the environment.

Several of the districts in the Northern Region mentioned that the method they use to treat roads minimizes the potential for ice to form due to temperature changes. Denali District (Northern Region) tries to clean salted sand off the road before temperatures drop below 25 °F so that ice is not formed. The Tok District noted that they prefer to use dry sand because mixing will dilute and refreeze into ice, and they need to keep roadways as dry as possible. The Fairbanks District uses crushed/screened/washed aggregate product, that they call their "winter sand," that does not freeze when stockpiled like traditional sand. They also limit sand and liquid use due to a lack of resources.

In the Southcoast Region, the Kodiak/Aleutian Chain District mixes sand and salt to keep sand piles from freezing. Another respondent from the Southcoast Region noted that they don't have an indoor, heated place to store their chemical truck to prevent chemicals from freezing, so they use an entire bag of product once it is opened. Respondents noted using local knowledge and experience to treat roadways and that product cost and efficiency are a factor. The Southeast District noted that their practices come from trying many deicers over the course of 50 years and they've chosen products that allow for the broadest coverage of terrain with the least number of chemicals (they treat from 11 feet to around 3,300 feet above sea level.

Table 11. Additional Details on Winter Maintenance

AKDOT Region	AKDOT Maintenance District	Feel free to explain why do you specific things.
Central	Anchorage	We are under an MS4 permit so we store all materials in a shed. We mix small batches as needed prior to loading sanders. This gives us a lot of control over our materials and allows us to minimize salt and brine impact on the environment. If conditions allow, we put just enough salt to allow sand to flow in box being applied.
Northern	Denali	If we use the salted sand, we try and get it off the road before the temp drops down below 25 degrees. We don't want to make ice with our salt.
Northern	Fairbanks	We do not treat or sand pile with salt as it is cost prohibitive due to the volume that we use. We use a crushed/screened/washed aggregate product that we call our winter sand. It does not freeze when stockpiled like traditional sand does. We also do not sand or apply liquid to the entire road due to insufficient resources to do so. We only treat those specific areas previously identified above.
Northern	Tazlina	As our road temps are typically very cold, we use sand to provide traction in icy areas.
Northern	Tok	We prefer dry sand because the mix will dilute and refreeze into ice. We try to keep our highway dry as possible, so the blowing snow won't stick to pavement
Northern	Valdez	We use brine when the roads have frosted or a light layer if black ice, sand is used when there is a buildup of packed snow or ice
Northern	Western	We use the 3-5% salt mixture because it does not freeze when storing the Highway sand piles outside throughout the winter. We sue only the NEWDEAL product for airports because no other product has stood up to the cold temperatures as advertised like the NEW DEAL products.
Southcoast	Kodiak/Aleutian Chain	Either temperature raise or drop in temp or freezing rain.
Southcoast	Kodiak/Aleutian Chain	For highways, sand and salt are mixed to keep our sand piles from freezing.
Southcoast	Kodiak/Aleutian Chain	Cost savings and get max benefit from product
Southcoast	Kodiak/Aleutian Chain	Local knowledge and geographic locations generally area treated as needed. Product cost and efficiency are factored as well.
Southcoast	Southeast	We use to get rid of black ice and prevent buildup of ice.

AKDOT Region	AKDOT Maintenance District	Feel free to explain why do you specific things.
Southcoast	Southeast	Culmination of trying many different types of deicers over 50 years that allow the broadest coverage of terrain with the least number of types of chemicals. In our instance we cover from 11 foot above sea level to just under 3,300 feet
Southcoast		To break the bond from asphalt to ice.
Southcoast		We do not have a place to store our chemical truck inside with heat to keep chemicals from freezing inside spreader. We must use the whole bag to keep product from freezing in the chemical spreader.

Corrosion Concerns

Half of respondents identified concerns about corrosion to personal, fleet, and commercial vehicles, with these concerns being reported from all AKDOT & PF regions (Figure 2, Table 12). The concerned respondents use the following products, with sodium chloride and sodium chloride/sand mixes being the most common:

- Sodium Chloride
- Sodium Chloride with RoadGuard +8
- Sodium Chloride/Sand Mix
- Hot Sand (75% Sand, 25% Sodium Chloride)
- Calcium Chloride (Dust Control)
- Magnesium Chloride
- Sand
- New Deal (Airports)
- Urea (Airports)
- Potassium Acetate (Airports)

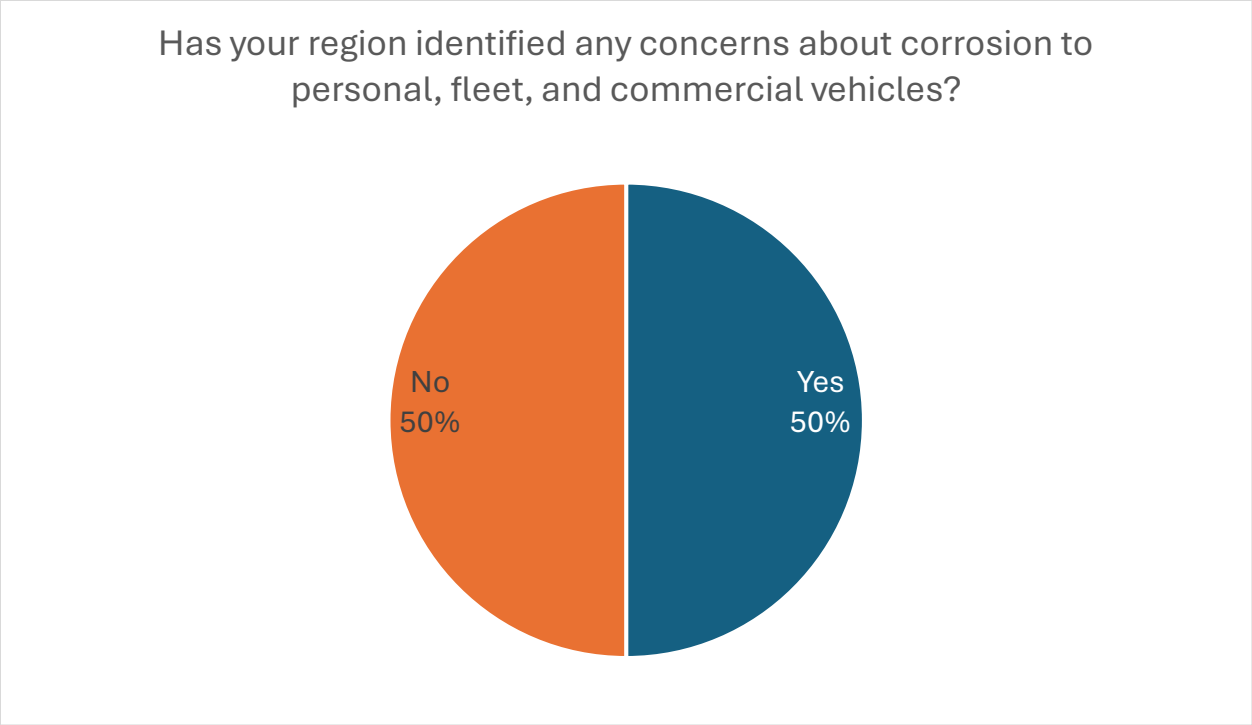

Figure 2. Has your region identified any concerns about corrosion to personal, fleet, and commercial vehicles?

Table 12. Respondents Deicing Products used and Corrosion Concerns.

AKDOT Region	AKDOT Maintenance District	DOT Roads	Local Roads (Paved)	Local Roads (Unpaved)	Pedestrian Facilities	Airports	Has your region identified any concerns about corrosion to personal, fleet, and commercial vehicles?
Central	Mat-Su					New Deal and Urea mixed with sand	Yes
Northern	Dalton	Dust control product - calcium chloride (varies from 3 bags to 8 bags per mile) each bag weighs 2400 lbs. If figured by volume effective blending is 2" x 30' x 1 mile x 8 cubic yards	None used	None	None	Potassium Acetate and Sodium Acetate/Formate Blend (New Deal) as needed	Yes
Northern	Fairbanks	Sodium chloride, Sodium chloride brine, Sodium chloride brine with RoadGuard +8 (typically 80%-20% blend), hot sand (75% sand – 25% sodium chloride blend) Summer Maintenance: Calcium chloride (dust control) on DOT gravel roads			Sidewalk deicer (Chinook Ultra Plus Ice Melt, Alaska Garden and Pet) or sodium chloride		Yes
Northern	Tazlina	We use sand mixed with 5% salt.	We use sand with 5% salt.			No deicer/Anti-icer used	Yes

AKDOT Region	AKDOT Maintenance District	DOT Roads	Local Roads (Paved)	Local Roads (Unpaved)	Pedestrian Facilities	Airports	Has your region identified any concerns about corrosion to personal, fleet, and commercial vehicles?
Northern	Tok	Sodium Chloride	Sodium Chloride	Calcium Chloride for dust control			Yes
Northern	Valdez	Salt Brine and Salt added to sand at 3%	Salt Brine and Salt added to sand at 3%	Salt Brine and Salt added to sand at 3%	Salt Brine and Salt added to sand at 3%	Urea solid and liquid potassium acetate	Yes
Northern	Western	3-5% salt/3/8" minus sand mixture	3-5% salt/3/8" minus sand mixture	3-5% salt/3/8" minus sand mixture	3-5% salt/3/8" minus sand mixture	Potassium Acetate liquid and New Deal deicer blend	Yes
Southcoast	Kodiak/Aleutian Chain	Salt Brine, @23.3%, 40 gal/lane mile, and pre-wet sand	Salt Brine, @23.3%, 40 gal/lane mile, and pre-wet sand	Only chemicals we put on gravel roads is calcium chloride @ about 1 ton/lane mile	Rock salt, spread by hand, unknown application rate	New Deal Deicing, Sodium Formate mix, 1-2 gal per linear ft. and pre-wet sand mixed @2200 per 800 gal	Yes
Southcoast	Southeast	We use premixed sand for all surfaces except at airports. The rate of use is 500yds sand with 30,000 lbs salt and 16,000 lbs calcium chloride.	See Above			We use a premixed sand 500 yards with 50,000 lbs of urea pellets.	Yes

AKDOT Region	AKDOT Maintenance District	DOT Roads	Local Roads (Paved)	Local Roads (Unpaved)	Pedestrian Facilities	Airports	Has your region identified any concerns about corrosion to personal, fleet, and commercial vehicles?
Southcoast		Rock salt solid with rust inhibitor. In years past it has been CG-90, ice slicer I am not sure what it is called now.				Only sand	Yes
Southcoast		Sand, Sodium Chloride 100%, Magnesium Chloride 100%					Yes

Corrosion Details

Respondents were then asked to provide additional details on corrosion concerns (Table 13) and a few respondents who did not initially report concerns with corrosion to personal, fleet, and commercial vehicles did reply to these questions.

Respondents reported problems with corrosion on plow trucks, equipment, and with vehicles in general; one respondent noted that most vehicles rust out within 12 years but small parts fail from corrosion long before that. Common parts that corrode include vehicle frames, vehicle underside, wiring, brake components, and other metal parts. One respondent reported challenges with all cast aluminum, most non-marine-grade aluminum, sheet metal, and steel other than stainless steel.

A respondent from the Kodiak/Aleutian Islands District noted that everyone is concerned with corrosion, however, it seems to be less of an issue in Kodiak due to higher volumes of rain that help wash vehicles.

Table 13. Corrosion Details

AKDOT Region	AKDOT Maintenance District	Has your region identified any concerns about corrosion to personal, fleet, and commercial vehicles?	Please explain.	Common parts that corrode?
Central	Mat-Su			Truck frames, brake components and wiring
Central	Mat-Su	Yes		Steel parts on sander unit
Northern	AKDOT Region	Yes	All things metal	All things metal, biggest issues with IT (wires and sensors)
Northern	Fairbanks	Yes		Truck frames, suspension components, sanders, liquid tanks, plows, underbody scrapers, wings, wire harness connectors, hardware, etc.

AKDOT Region	AKDOT Maintenance District	Has your region identified any concerns about corrosion to personal, fleet, and commercial vehicles?	Please explain.	Common parts that corrode?
Northern	Tazlina	Yes	Yes we have seen problems with corrosion on plow trucks.	Frames, air valves, brake cans
Northern	Tok	Yes		Frame rails of trucks with chassis mount sanders
Northern	Valdez	Yes	We have seen issues with corrosion to the plow trucks that apply the products.	Frames and brake systems and electrical connections.
Northern	Western	Yes	Mechanics seem to be the ones that notice it the most on frames and running gear of the equipment. Otherwise very little said because we live along the ocean, and it is already a corrosive environment.	Wheel rims, under chassis components, and running gear
Southcoast	Kodiak/Aleutian Chain	Yes	I think everyone is concerned about corrosion, the State of Alaska as well as the public. Corrosion seems to be less of an issue in Kodiak due to high rain precipitation amounts washing vehicles. There is still high corrosion here just because we are an island in a marine environment. There are no concerns from	State sander/tanker trucks usually experience electrical corrosion and metal corrosion in the under-vehicle parts. Sometime vehicles body panels will corrode in double walled areas hard to wash.

AKDOT Region	AKDOT Maintenance District	Has your region identified any concerns about corrosion to personal, fleet, and commercial vehicles?	Please explain.	Common parts that corrode?
			the aviation community with sodium formate.	
Southcoast	Kodiak/Aleutian Chain	No		The only thing that starts to corrode is the piece of equipment we use to apply the chemical (salt).
Southcoast	Southeast	No		All exposed parts.
Southcoast	Southeast	No		Under carriage
Southcoast	Southeast	No		Car Frame
Southcoast	Southeast	Yes	Most vehicles rust out within 12 years but long before that the many small parts fail from corrosion.	All cast aluminum, most non-marine grade aluminums, sheet metal, pot metal objects then any steel other than stainless steel.
Southcoast			The equipment that distributes brine have corrosion.	Undercarriage and brakes
Southcoast		Yes	The type of chemicals that have been used here (rock salt solid) cause corrosion to vehicles and shorten the lifespan of them.	All parts on the underside of vehicles.
Southcoast		Yes	Unknown on personal vehicles but take concerns about fleet vehicles.	Frames, brake pads
Southcoast		No		Frames on cars

Public Complaints

Just over one third of respondents noted receiving complaints or concerns from the public related to corrosion of vehicles (Figure 3). However, some respondents noted that while they have not received official complaints it is a known issue (Table 14).

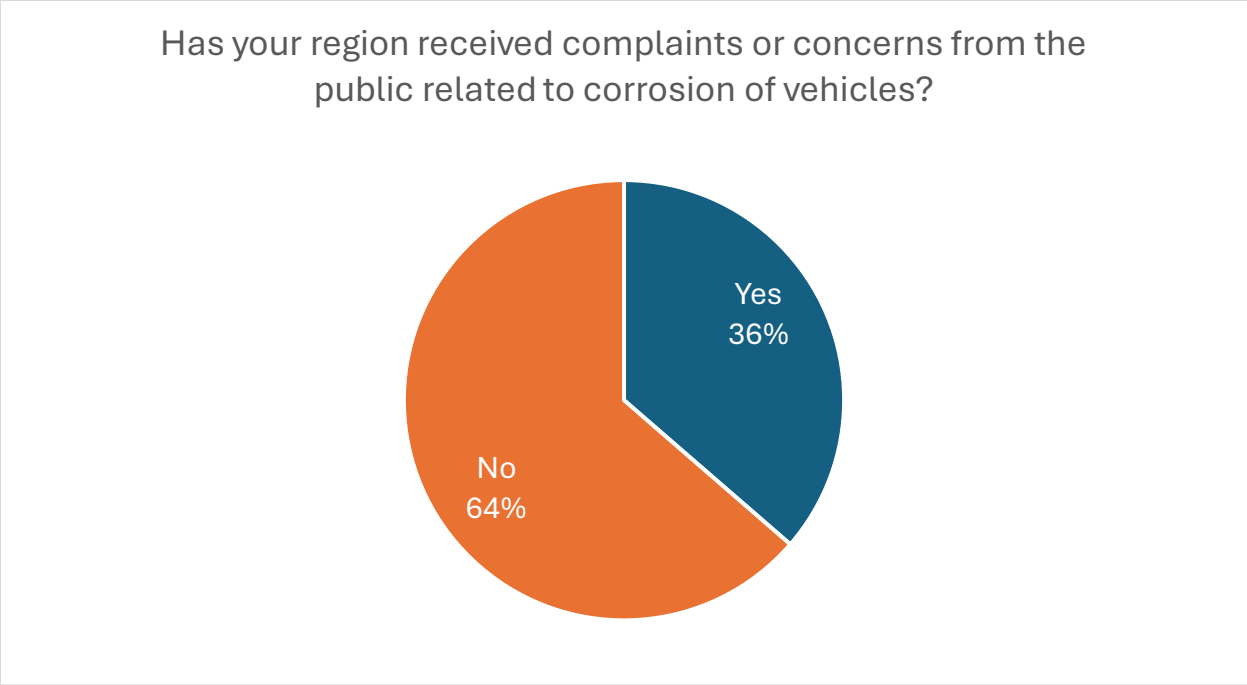

Figure 3. Has your region received complaints or concerns from the public related to corrosion of vehicles?

Table 14. Corrosion concerns and complaints

AKDOT Region	AKDOT Maintenance District	Has your region identified any concerns about corrosion to personal, fleet, and commercial vehicles?	Has your region received complaints or concerns from the public related to corrosion of vehicles?
Central	Anchorage		No
Central	Mat-Su		Some
Central	Mat-Su	Yes	No
Northern	Dalton	Yes	Yes
Northern	Fairbanks	Yes	Yes
Northern	Tazlina	Yes	No
Northern	Tok	Yes	Not as much as those areas that use salt brine.
Northern	Valdez	Yes	Yes
Northern	Western	Yes	Not so much for complaints. Haven't gotten any that I am aware of.

AKDOT Region	AKDOT Maintenance District	Has your region identified any concerns about corrosion to personal, fleet, and commercial vehicles?	Has your region received complaints or concerns from the public related to corrosion of vehicles?
Southcoast	Kodiak/Aleutian Chain	Yes	We used to when we only used rock salt. I have not heard any complaints in years. Probably since using brine which is easily washed off in comparison to rock salt that can get flipped into hard-to-reach areas and take a while to dissolve.
Southcoast	Kodiak/Aleutian Chain	No	No
Southcoast	Kodiak/Aleutian Chain	No	No
Southcoast	Kodiak/Aleutian Chain	No	No
Southcoast	Southeast	No	No
Southcoast	Southeast	No	No
Southcoast	Southeast	No	No
Southcoast	Southeast	No	No
Southcoast	Southeast	Yes	Unknown about road complaints, but the airport users have voiced concern about urea decaying into ammonia and effecting planes and fish.
Southcoast			No
Southcoast		Yes	We do not receive official complaints to the station. It has always been known it is a part of life to live here.
Southcoast		Yes	I haven't heard much since I've been foreman.
Southcoast		No	Yes

Best Practices to Reduce Corrosion

Respondents were then asked whether their region utilizes any of the following best practices to reduce or prevent corrosion: wash vehicles, use a corrosion inhibitor in deicer, use a salt neutralizer, or other. Washing vehicles was the most common response with all

respondents using this best practice (Figure 4). This was followed by using a corrosion inhibitor. Four respondents noted that they use another method, including using Black-Max, a cathodic rust arrestor, once a year, or other undercoating or corrosion inhibitors (Table 15).

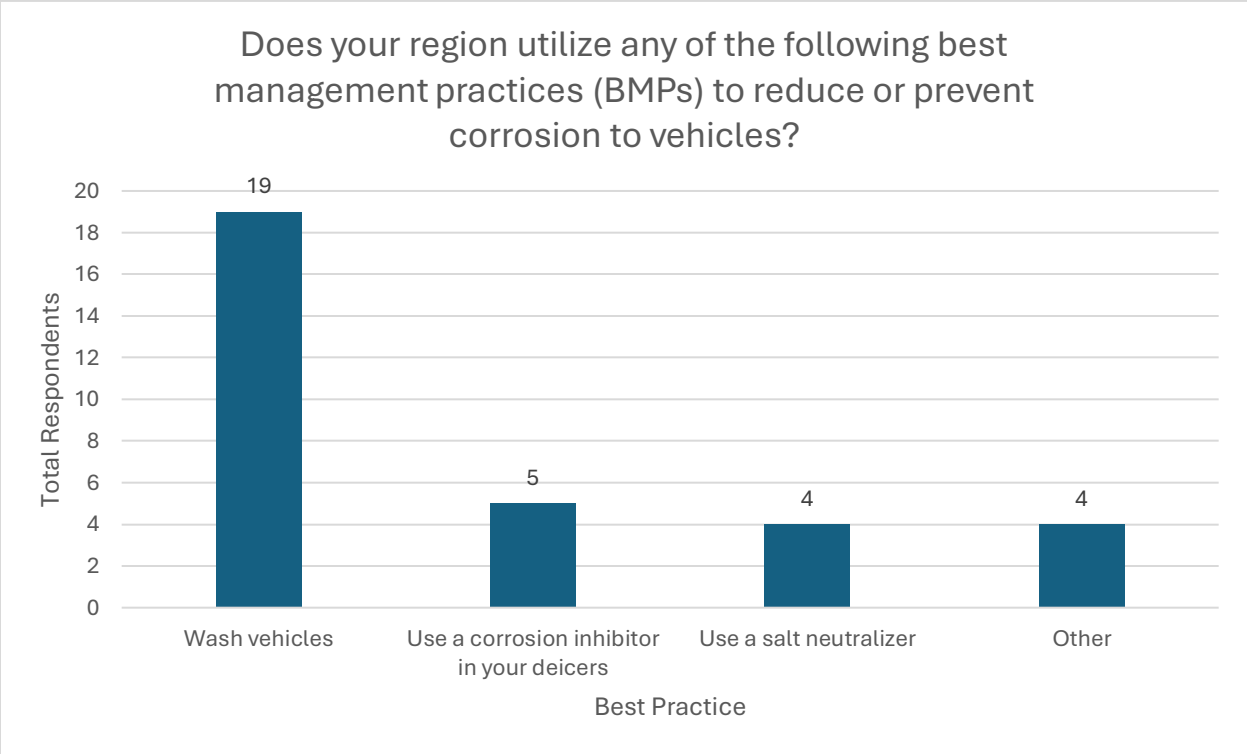

Figure 4. Does your region utilize any of the following best practices to reduce or prevent corrosion: wash vehicles, use a corrosion inhibitor in deicer, use a salt neutralizer, or other?

Table 15. Other Practices to Reduce or Prevent Corrosion

AKDOT Region	AKDOT Maintenance District	Other	Other Text Response
Northern	Tazlina	x	We use Black-Max (cathodic rust arrestor) applied to the frames once a year at seasonal change over.
Northern	Western	x	Use non-corrosive products on the airports.
Southcoast	Kodiak/Aleutian Chain	x	We spray corrosion inhibitors like Corrosion X or such products on electrical connections and components periodically.
Southcoast	Southeast	x	Undercoating and spray films

Level of Service Guidelines

Last, respondents were asked to share their Level of Service guidelines. The Anchorage Maintenance District provided a link to their road priority levels, here: https://dot.alaska.gov/nreg/blog/blog23.shtml#:~:text=Priority%20Level%201%3A%20high%2Dvolume,traffic%20volume%2C%20speeds%20and%20uses.

They include five priority levels, ranging from "high-volume, high-speed highways" (Level 1) to "no winter maintenance routes" (Level 5). A description from the website is provided below for context.

"Priority 1 roads receive the most winter maintenance, followed by Priority 2, Priority 3 and, finally, Priority 4. Priority 5 roads do not receive winter maintenance. In communities without Priority 1 roads, staff will begin by clearing the Priority 2 roads or whichever roads are of highest priority within the district. The five priority levels are defined as:

- **Priority Level 1:** high-volume, high-speed highways, expressways, minor highways, all safety corridors and other major urban and community routes.
- **Priority Level 2:** routes of lesser priority based on traffic volume, speeds and uses. Typically, these are major highways and arterials connecting communities.
- **Priority Level 3:** major local roads or collector roads located in larger urban communities.
- **Priority Level 4:** minor local roads that provide residential or recreational access.
- **Priority Level 5:** roadways that are designated as "No Winter Maintenance" routes, e.g. Denali Highway or Taylor Highway."

Survey respondents shared Chapter 7 from the Alaska DOT & PF Highway Maintenance and Operations Handbook and a more detailed description of Priority Level 2 Roads.

Synthesis on Corrosion Caused by Deicers and BMPs that can be used to Prevent or Reduce Corrosion

Corrosion from Deicers

Corrosion caused by chloride-based deicers can impact equipment, vehicles, and infrastructure. This synthesis is focused on identifying common corrosion impacts to personal and commercial vehicles, including trucks and equipment. Common forms of corrosion that occur on vehicles and equipment are general corrosion and localized corrosion such as pitting, crevice, filiform, intergranular, galvanic, stress cracking, fatigue, erosion, fretting, and microbially induced (Shi et al., 2005). Modern vehicles are made of many metal types, including carbon steel, cast iron, aluminum alloys, magnesium alloys, and copper and copper alloys, all of which, either alone or as connected systems, can be impacted by corrosion from chloride-based deicing products (Shi et al., 2005; CTC & Assoc., 2023).

Deicers used in winter maintenance operations on roadways, pedestrian paths, and airports aid in keeping these facilities open and safe for all users. Chloride-based deicers, sodium chloride (salt brine or rock salt), magnesium chloride (mag), and calcium chloride, are the most commonly used products in winter operations. These chlorides can be used as liquids or solids to help prevent snow and ice from bonding with the roadway, to aid in plowing, or to help burn through packed snow and ice on roadways and improve friction. Magnesium chloride and calcium chloride are used as dust suppressants on unpaved roads in Alaska. Chloride-based deicers are known to cause corrosion to infrastructure, vehicles, and equipment (Wood, 1976; Shi et al., 2009a,b; Li et al., 2013). Impacts on metals and roadways have been found to occur to a lesser extent from other deicer types, including acetates, formates, and glycols (Nilsson, 2003; Pan et al., 2008; Shi, 2008; Shi et al., 2009a, Anastasio et al., 2015; Xie et al., 2017).

Cost of Corrosion

Departments of Transportation have reported corrosion costs of $1 million to $14 million per year, with research suggesting that up to 30% of these costs are avoidable if proactive corrosion prevention programs are in place, including the use of anti-corrosion coatings, periodic washing with hot water at low pressure/fast drying, and specific vehicle designs (e.g., corrosion resistant metals, rounded corners) (AHMCT Research Center, 2018).

Shi et al. (2013) evaluated corrosion of DOT equipment and found general corrosion costs related to training programs, material selection, design improvements, corrosion monitoring and testing, proactive maintenance, and reactive maintenance to be over $1

million per year (2013 US Dollars, or ~$1.4 million in 2024[1]). They found DOT fleet vehicle and snowplow average corrosion repair costs were about 4.3–9.3% of the total repair budget. For vehicles to achieve their design life, specific components needed to be replaced more frequently or with components that had corrosion protection that made them more expensive. They determined that deicer corrosion leads to a 17.3% reduction in equipment service life or, in this case, a loss of three years of service life. They estimated that about 20% of corrosion-related costs could be reduced by increasing investment in equipment corrosion management and focusing on proactive maintenance.

For personal vehicles, an American Automobile Association (AAA) survey estimated corrosion costs of $3 billion annually just from rust repairs, with the average cost of these repairs equaling $490 per vehicle (2017 US Dollars, or $630 in 2024[1]; AAA, 2017). Work by Vitaliano (1992) found vehicle corrosion from deicers cost $113 per ton of applied salt (1992 US Dollars, or $254 in 2024[1]). On the other side of this issue, a study in a Scandinavian country found that cars driven on salt-free roads were 50% less likely to have cosmetic corrosion issues (Rendahl and Hedlund, 1992).

Corrosion does not only cause damage like rusting but may also lead to vehicle and equipment depreciation, equipment downtime, reduced reliability, reduced service life, increased premature repairs and replacement, and safety risks from faulty (re: corroded) parts (Shi et al., 2013; Li et al., 2013).

While cost information is limited and dated, the good news is that the use of best practices is effective at reducing corrosion to equipment and personal vehicles. Best practices to reduce and prevent corrosion to equipment and personal vehicles are discussed below.

[1] Inflation Tool: inflationtool.com

Best Practices to Prevent Corrosion and Reduce Impacts to Vehicles and Equipment

A review of the literature on vehicle corrosion related to deicer use found several proactive methods to prevent corrosion to vehicles and equipment. These methods include barrier protection (e.g., inhibitive coatings, anti-corrosion coatings), galvanization, cathodic protection, washing of vehicles and equipment (including the use of salt removers and/or salt neutralizers), corrective methods (e.g., dielectric grease in electrical connections), and design considerations (e.g., enclosed wiring; Casey et al., 2014; Jungwirth et al., 2016; Nazari & Shi, 2018; Qian et al., 2015). Details on each of these methods are provided below.

Anti-Corrosion Coatings

Coatings are commonly used in the automotive industry to prevent corrosion by reducing the interaction between metal in a vehicle or equipment and a corrosive environment. Anti-corrosion coatings are generally categorized as barrier protection, inhibitive coatings, or anodically active metal coatings (Qian et al., 2015).

Barrier protection prevents oxygen, water, salt, and debris from reaching the vehicle or equipment surface (Qian et al., 2015). Inhibitive coatings alter the chemistry at the surface of the vehicle. Anodically active metal coatings are usually made of zinc and prevent electrical currents from discharging from the substrate (e.g., prevent galvanic corrosion). Metallic coatings, typically zinc or zinc-containing alloys, are widely used to protect against the corrosion of metals. These coatings serve two functions: they act as a barrier and provide cathodic protection by galvanically corroding (Shi et al., 2013).

Hexavalent chromium was a commonly used anti-corrosive coating on vehicles from the original equipment manufacturer (OEM) but has since been banned because it was a proven carcinogen. Car manufacturers now use a variety of metal coatings, but they do not appear to be as effective in preventing corrosion (Rubin et al., 2010).

When applying coatings, Mehdi et al. (2015) noted that proper surface preparation is key. This preparation includes utilizing a salt remover and/or grit blasting the surface before applying coatings. Generally, thicker coatings will last longer; however, the effective thickness of one coating cannot be compared to another (Qian et al., 2015).

Commercially Available Anti-Corrosion Coatings

Several studies have aimed to test the effectiveness of anti-corrosion coatings. The findings of these studies are described below.

Testing by Li et al. (2013) found that Rust Bullet (inhibitive coating), Krown (inhibitive coating), HoldTight (salt remover), and ChlorRid (salt remover) were the best-performing products for carbon steel exposed to $MgCl_2$. A previous study found that a one-time

application of Rust Bullet (a protective coating) reduces the corrosion rate by 99.5% (Shi et al., 2013).

In a study conducted by Ohio DOT, light-curable coatings were found to be the most effective treatment at preventing corrosion, whereas OEM and LubraSeal were found to have visible deterioration and rusting (Monty et al., 2014).

In a recent study from Clear Roads, Fluid Film was found to provide maximum corrosion protection to steel and aluminum alloys and was most commonly used by those surveyed due to the products' low cost and ease of application (Jamal & Shi, 2024). In addition to Fluid Film, Aquapon (a zinc-rich epoxy primer), was also found to be an effective coating due to its high resistance to abrasions, scratching, and indentations (Jamal & Shi, 2024).

A list of coating products identified twenty-two products currently on the market (Table 16).

Table 16. Coating Products

Product	Company	Description	Estimated Price	Link
Cavity Wax	3M	Cavity Wax is a non-hardening, self-healing corrosion protection coating for internal body panels, frame rails, and structural enclosures.	$32.05 per 18 oz can	https://www.3m.com/3M/en_US/p/d/b40066669/
Weld-Thru Coating	3M	Weld-Thru Coating is a zinc-based spray-on coating which protects bare metal panels and parts from corrosion after welding.	$43.04 per 12.75 oz can	https://www.3m.com/3M/en_US/p/d/v000056390/
Carwell Rust Inhibitor CP90	Carwell Corrosion Control	Carwell Rust Inhibitor is a clear liquid blend of rust inhibitors that creates an active barrier to repel salt and moisture. It should be applied every 6–9 months in corrosion-prone environments (coastal, heavy industrial areas). This product has been used by local departments of transportation to protect salt spreading equipment.	$52.50 per gallon	https://www.carwell.com/product/t32-cp90-1-gallon-jug/
CorrBarrier Primer	Cortec	CorrBarrier Primer is a water-based, one-coat system for underbody/under-hood protection.	Not available	https://www.corteccoatings.com/product/corrbarrier/
VpCl-398	Cortec	VpCl-398 is a solvent-based sulphonate one-coat system which can be applied directly to metal.	$87 per gallon	https://www.corteccoatings.com/product/vpci-398/
Nox-Rust 4490, Nox-Rust 4495	Daubert Chemical Company, Inc.	Nox-Rust 4490 and Nox-Rust 4495 are annual rust-proofing coatings for vehicles in cold climates.	$30 per gallon (typical usage is	https://www.daubertchemical.com/coatings/automot

Product	Company	Description	Estimated Price	Link
			1–2 gallons per vehicle)	ive-transportation/annual-rust-proofing-underbody/
Fluid Film	Eureka Chemical Company	Fluid Film is a penetrant and lubricant also used for corrosion prevention. It is formulated from specially processed wool-wax, highly refined petroleum oils, and selected agents to provide corrosion control, penetration, metal wetting, and water displacement. This product was tested in the Update to CR 13-04: Best Practices for Protecting DOT Equipment from the Corrosion Effect of Chemical Deicers.	$50 per gallon	https://www.fluid-film.com/
Zero Rust	Gemini-Coatings	Zero Rust is a direct-to-metal primer available in several colors, high solid phenolic-modified alkyd coating which controls and prevents rust/corrosion. It is a proprietary blend of sealants and lubricants. It goes on as a black liquid that dries down to a thin, flexible polymer skin. This product was listed in the literature review (2013 - Corrosion by Chloride Deicers on Highway Maintenance Equipment).	$80 per gallon (covers 288 sq ft)	https://www.usezerorust.com/wp-content/uploads/2019/03/2019.Zero_.Rust_.brochure.pdf
Krown Rust Protection & Lubricants	Krown	Krown Rust is a petroleum-based product which requires annual application. This product can be applied to electrical connections, body panels, spot welds/seams, brake cables, etc.	$170 for a heavy-duty pickup truck, commercial pricing available on request $15 for 400G can	https://www.krown.com/en/ https://www.krown.com/en/products/aerosols/rust-protection-lubricants/

Product	Company	Description	Estimated Price	Link
Boss Wax and Oil	NHOU Protective Coatings	Boss Wax and Oil is a semi-permanent rust protection for new vehicles.	$48 per gallon	https://nhoilundercoating.com/rust-prevention-rustproofing-nhou/
NH Oil Undercoating	NHOU Protective Coatings	NH Oil Undercoating is an oil-based rust proofing that is applied using high pressure that pushes the coating into seams, cracks, etc. Annual reapplications are recommended.	$56 per gallon	https://nhoilundercoating.com/
POR-15 Rust Preventive Coating	Paint Over Rust Products	POR-15 Rust Preventive Coating is for use on chassis, doors, floors, trunk areas, suspension, engines, and fuel tanks. It can be applied on prepped, rusted, or seasoned metal surfaces.	$220 per gallon, a quart will cover 50 sq ft with two coats	https://por15.com/products/rust-preventive-coating?variant=42895337750695
Aquapon	PPG Protective and Marine Coatings	Aquapon is a zinc-rich epoxy primer which provides corrosion resistance. This product was tested in the Update to CR 13-04: Best Practices for Protecting DOT Equipment from the Corrosion Effect of Chemical Deicers.	Not available	https://www.ppgpmc.com/products/aquapon-97-670-series
ARMOUR-Seal	Rhomar	ARMOUR-Seal is a semi-permanent, professional grade, rubberized undercoating that can be applied to frame and chassis components including air brake chambers, transmission pans, and oil pans.	$250 per dozen quart sized bottles (takes 2-4 quarts to protect a chassis)	https://rhomar.com/products/armour-seal/

Product	Company	Description	Estimated Price	Link
Lubra-Seal	Rhomar	Lubra-Seal protects salt spreads/sanders from rust and corrosion during summer storage and provides lubrication during the winter season. This product was listed in the literature review (2013 - Corrosion by Chloride Deicers on Highway Maintenance Equipment).	$49 per gallon	https://rhomar.com/products/lubra-seal/
Rust Bullet	Rust Bullet, LLC	Rust Bullet is a moisture-cured urethane coating that is very stable when exposed to UV, weathering, and hydrolysis. It can be applied over rusted, clean, and new metal surfaces. This product was listed in the literature review (2013 - Corrosion by Chloride Deicers on Highway Maintenance Equipment) as the best performing coating of those tested.	$56.99 per quart or $177.99 per gallon	https://www.rustbullet.com/product-category/rust-inhibitors/automotive/
S2S Automotive Rust Proofing	Ship-2-Shore	S2S Automotive Rust Proofing is a non-tacky coating that is self-healing with no curing time and works on dissimilar metals. This product was listed in the literature review (2013 - Corrosion by Chloride Deicers on Highway Maintenance Equipment).	Not available	https://ship-2-shore.com/products/commercial-products/automotive-rust-proofing/
Undercoating in a Can	Undercoating in a Can	Undercoating in a Can is a wax-based self-healing undercoat for metal and wood surfaces.	$80.44 per gallon	https://undercoatinginacan.com/#2

Product	Company	Description	Estimated Price	Link
Undercoating in a Can Clear Fluid Coat	Undercoating in a Can	Undercoating in a Can Clear Fluid Coat is a petroleum-based protective coating. This coating should be used semi-annual to annually.	$37.86 per gallon	https://undercoatinginacan.com/undercoating-in-a-can-clear-fluid-coat/
Undercoating in a Can Rubberized	Undercoating in a Can	Undercoating in a Can Rubberized is a high polymerized rubber coating which can be top coated with automotive paint. This product should only be applied to surfaces free of corrosion.	$84.53 per gallon	https://undercoatinginacan.com/#2
ValuGard - Rust Prevention	ValuGard	ValuGard has a wax-based rust inhibitor and two under coatings which provide corrosion protection tested against magnesium and calcium chloride deicing brines.	$23.13 per quart of VG-101 or $35.61 per gallon (the estimated cost to treat a standard plow truck is $153.55)	https://valugard.net/products/rust-prevention-products.html
Z-Guard	Ziebart	Z-Guard is a durable, thixotropic, corrosion-preventative undercoating for underbody components. Z-Guard is applied using airless spray equipment.	$29 per quart	https://petroleumservicecompany.com/z-guard-8000-undercoating/

Washing Vehicles & Equipment to Prevent Corrosion

Washing vehicles (personal or work) and equipment regularly can prevent corrosion from causing serious damage to their components. The frequency of washing necessary is dependent on the vehicle type and use. In winter months when deicers are actively applied to roadways, a good rule of thumb is to wash a:

- Personal vehicle once a week.
- Plow truck daily after deicer application.

Salt Neutralizers & Salt Inhibitors

Washing vehicles and equipment in coordination with a salt neutralizer is a best practice to minimize corrosion after exposure to deicers.

In a study conducted by Ohio DOT, Salt Away was found to reduce corrosion on aluminum, stainless steel, carbon steel, copper, and brass metal samples and was the top performer compared with BioKleen, ConSALT, Eastwood, Neutro-Wash, and Winter Rinse. Neutro-Wash was effective in preventing corrosion on copper and aluminum (Monty et al., 2014). Pure vinegar and 5% by wt. sulfamic acid showed reduced corrosion on carbon steel and was used as a control. The performance of salt neutralizers is greatly affected by the dilution rate. At a high enough concentration, all salt-neutralizing products were effective at preventing corrosion on carbon steel; however, using a high concentration could decrease the cost-effectiveness.

The estimated cost per truck, using 350 gallons of wash, was $567 for Salt-Away (one of the top-performing salt neutralizers; Monty et al., 2014). They recommended washing the truck with soap and water first, then targeting the salt-neutralizer solution at areas of concern (i.e. carbon steel) using 100 gallons of neutralizer per wash. Assuming that these products can increase the useful life of a truck by 6 months to one year, washing the truck with Salt-Away 5 to 18 times per year on average, depending on location and replacement cycle, was found to be cost-effective.

Iowa DOT noted good results using Salt-Away as a post wash to remove chloride from trucks (CTC & Assoc., 2016). Tennessee DOT uses Neutro-Wash to wash vehicles and vehicle undercarriage to remove chlorides. They also use Lubra-Seal on chains and gears on their v-box spreaders at the end of each winter season.

Several available salt-neutralizer products were identified and are detailed in Table 17.

Table 17. Salt Neutralizer Products

Product	Company	Description	Estimated Price	Link
AGS Rust Solutions, Salt Neutralizer Concentrate				https://rustsolutions.com/products/salt-neutralizer-gallon
Salt Kleen	Bio Kleen	Salt Kleen is a salt neutralizer that is applied and rinsed away with water to remove salt debris.	$31.95 per gallon	https://www.biokleen.com/salt-neutralizer
ConSALT	EaCo Chem		Not available	https://eacochem.com/eaco_products/_product_consalt/
Eastwood Road Salt Neutralizer	Eastwood	Eastwood Road Safety Neutralizer is a salt neutralizer that is mixed with water and hosed off to clean metal substrates exposed to road salt.	$28.97 per gallon	https://www.eastwood.com/eastwood-road-salt-neutralizer-gallon.html
Salt Brine Eliminator	NHOU Protective Coatings	Salt Brine Eliminator is a salt remover designed for heavy duty applications.	$50-$200	https://nhoilundercoating.com/product/nhou-salt-brine-eliminator/
NEUTRO-WASH	Rhomar	NEUTRO-WASH was developed to eliminate rust and corrosion damage to public works trucks and salt spreaders by removing the corrosive chemicals used to deice roadways. No complicated process is required: wash the truck or spreader as normal, then apply diluted NEUTRO-WASH and let sit for 2 to 3 minutes. Finally, rinse with cold water and the salt is gone.	$36.95 per gallon, prices decrease with bulk purchases	https://rhomar.com/products/neutro-wash/

Product	Company	Description	Estimated Price	Link
Salt Away	Salt Away	Salt-Away is a salt-removing product to install in your car or truck wash in cold regions where road salt is applied to roads.	$48.00 per gallon	https://www.saltaway.com/

Reducing the Possibility of Corrosion with Design Elements

In addition to the best practices described above, there are design considerations that can reduce the risk of corrosion when procuring new vehicles and equipment. These design considerations include avoiding areas that can trap or accumulate liquids, providing easy drainage for exposed surfaces, minimizing welding joints and gaskets, avoiding crevices between dissimilar metal alloys, and configuring equipment design to allow maximum access for maintenance and repair painting (Jungwirth et al., 2016). Utah DOT noted that after observing frame cracking due to corrosion, they moved to single rail frame vehicle designs (AHMCT Research Center, 2018).

In addition, certain metal alloys are more corrosion resistant. A survey of transportation agencies found that cast irons tend to experience the most general corrosion, followed by carbon steels. Aluminum alloys and stainless steels experience the most localized corrosion, followed by metallic glass. One survey respondent noted that stainless steel components tend to last 25–100% longer than carbon steel components (Jungwirth et al., 2016).

Reducing Corrosion to Electrical Components

The following changes in practices and modifications to existing designs can aid in reducing corrosion to electrical components:

- Installing waterproof/weatherproof connectors
    - Two electrical connector product lines were identified by CTC & Assoc. (2023): Deutsch (TE Connectivity) and Weather Pack (Aptiv). Those using Deutsch products noted their “weatherproof” properties and that they are easy to connect and disconnect, and that dielectric grease is beneficial for installation.
- Cleaning connectors frequently
- Using dielectric silicone and dielectric grease for sealing connections
- Applying heat tubing to cover the crimped area where a new terminal meets a wire
- Relocating junction boxes inside the cab and off the floor of the vehicle
- Using continuous wiring to minimize the number of connectors

More cutting-edge technologies include anti-corrosion treatments for aluminum wiring; thin, protective coatings of graphene for metallic connectors and electrical terminals; NiobiCon, which is a new connector designed for equipment operating in corrosive environments; improvements in molding plastics used in the automotive industry; and SuperCURR-A which is a “self-healing” compound used as an ultra-thin film coating that lubricates and protects electrical components from corrosion (CTC & Assoc., 2023).

Other Equipment Design Modifications

In a workshop on corrosion protection, Ohio DOT shared several design modifications they have utilized to prevent corrosion. These included relocating power boxes into the cab of the vehicle and cutting one-inch holes into the front of their truck beds to allow air circulation to dry out the vehicle frame (AHMCT Research Center, 2018). Nazari et al. (2015) recommends avoiding drilling unnecessary holes and recommends painting or coating the drilled edges.

A recent survey for Clear Roads found that 66.2% of respondents had redesigned vehicle and equipment components by replacing materials that are prone to corrosion with corrosion resistant materials, primarily switching from carbon steel to stainless steel (Jamal & Shi, 2024).

Additional modifications suggested by Nazari et al. (2015) include using welds to close and seal off areas that are difficult to drain, caulking welds prior to painting, injecting polyurethane foam into cavities, and utilizing underbody splash shields. Where welded joints are needed, continuous welds are recommended instead of tack or skip welds.

As vehicles and equipment age and get rust spots, a best practice is to wash the area, sand off the rust, and repaint the area to provide a protective barrier between the elements and the metal surface (Nazari, 2015).

Cost of Corrosion Prevention

A survey of 106 transportation agencies found the average annual cost of corrosion prevention in six areas, described in Table 18 (Shi et al., 2013). Investment in proactive maintenance to prevent corrosion is more cost-effective than reactive maintenance. They estimated that about 20% of corrosion-related costs could be reduced by increasing investment in equipment corrosion management and focusing on proactive maintenance.

Work by Rodriguez et al. (2020) for the state of Ohio found that protective coatings increase equipment service life and reduce maintenance costs. Findings show that polyurethane and UV-cured coatings are the most cost-effective options, leading to potential savings of $3,500–4,000 per truck over ten years, or millions of dollars in savings if this practice is expanded to the entire fleet.

Table 18. Average Annual Cost of Corrosion Prevention (Shi et al., 2013)

Corrosion Prevention Area	Average Annual Cost in 2013 Dollars	Average Annual Cost in 2024 Dollars[2]
Training Programs	$190,938	$258,562
Materials Selection	$320,667	$434,237
Proactive Maintenance (i.e., salt neutralizers, anti-corrosion coatings)	$171,424	$232,137
Corrosion Monitoring/Testing	$10,000	$13,542
Design Improvements	$45,000	$60,938
Reactive Maintenance (i.e., treating existing corrosion)	$325,000	$440,105

Conclusions

Many known best practices can be used to prevent or reduce corrosion to personal vehicles and equipment. Putting these into practice may require a little extra time and money but can provide cost savings and reduce corrosion in the long run (as noted in the Cost of Corrosion Prevention section, proactive maintenance is cheaper than reactive maintenance).

Suggestions for the DOT include:

- Be proactive, not reactive
- Implement a proactive fleet management plan that considers corrosion prevention
- Implement corrosion-related training
- Routinely inspect equipment and vehicles for corrosion damage
- Avoid equipment designs that are more susceptible to corrosion (e.g., single rail frame compared to double or nested “C” channel frames)
- Move electrical components into the cab of the vehicle where possible
- Consider equipment and vehicle storage that would avoid freeze-thaw cycles
- Wash frequently
- Implement reactive practices like neutralizing existing corrosion through grit blasting and salt neutralizers
- Repair scrapes, dents, etc. in a timely manner to protect raw metal from exposure to corrosive materials
- Use protective or sacrificial coatings

Suggestions for personal vehicles include:

- Consider vehicle storage that would avoid freeze-thaw cycles

[2] Inflation Calculator: https://www.inflationtool.com/

- Wash frequently (weekly if feasible)
- Repair scrapes, dents, etc. to protect raw metal from exposure to corrosive materials
- Allow sufficient driving distance between vehicles to avoid sand and rock hits.

Every operation will find what works best for them, and it will likely vary due to cost, available time, resources allocated, and, specifically in Alaska, what is available and realistically feasible. Collecting data related to corrosion costs and corrosion prevention measures would allow a cost-benefit analysis to be conducted.

A summary of common corrosion types and best practices to reduce or prevent corrosion is provided in Table 19.

Table 19. Summary of common corrosion types and best practices to reduce or prevent corrosion (recreated from Nazari et al., 2015).

Type of Corrosion	Best Practice
General Corrosion	Regular washing Use of salt neutralizers Good design considerations/material selection Anti-corrosion coatings
Localized Corrosion	
Pitting Corrosion	Regular washing Use of salt neutralizers Anti-corrosion coatings
Crevice Corrosion	Regular washing Use of salt neutralizers Good design considerations—properly welded joints, sealed joints Anti-corrosion coatings
Filiform Corrosion	Regular washing Use of salt neutralizers Anti-corrosion coatings
Intergranular Corrosion	Regular washing Use of salt neutralizers Good material selection
Galvanic Corrosion	Regular washing Use of salt neutralizers Good material selection—use similar metal alloys, electrically insulate dissimilar metal junctions
Stress Corrosion Cracking	Regular washing Use of salt neutralizers Good material selection—use of high strength steels

Type of Corrosion	Best Practice
Corrosion Fatigue	Regular washing Use of salt neutralizers Good design considerations—remove notches or other stress-concentrating features, rounded angles
Erosion Corrosion	Regular washing Use of salt neutralizers Good design considerations—avoid abrupt angles/channels that impede flow of liquids
Fretting Corrosion	Regular washing Using appropriate lubrication
Microbially Induced Corrosion (for those using bio-based snow and ice chemicals)	Regular washing Use of salt neutralizers Prevent growth/formation of biofilms Coatings with antimicrobial or hydrophobic properties

Recommendations

- Test the corrosion performance of inhibitors in the concentrations at which they are blended. For example, GLT 3-5%. Often, corrosion data reported is based on higher concentrations.
- Design future maintenance facilities to include indoor, drive-through wash bays that allow truck washing and drying in winter months.
- Develop, implement, and train a routine vehicle and equipment inspection plan that proactively mitigates corrosion.

Corrosion Fact Sheets for DOT Truck and Equipment and Personal Vehicle Users

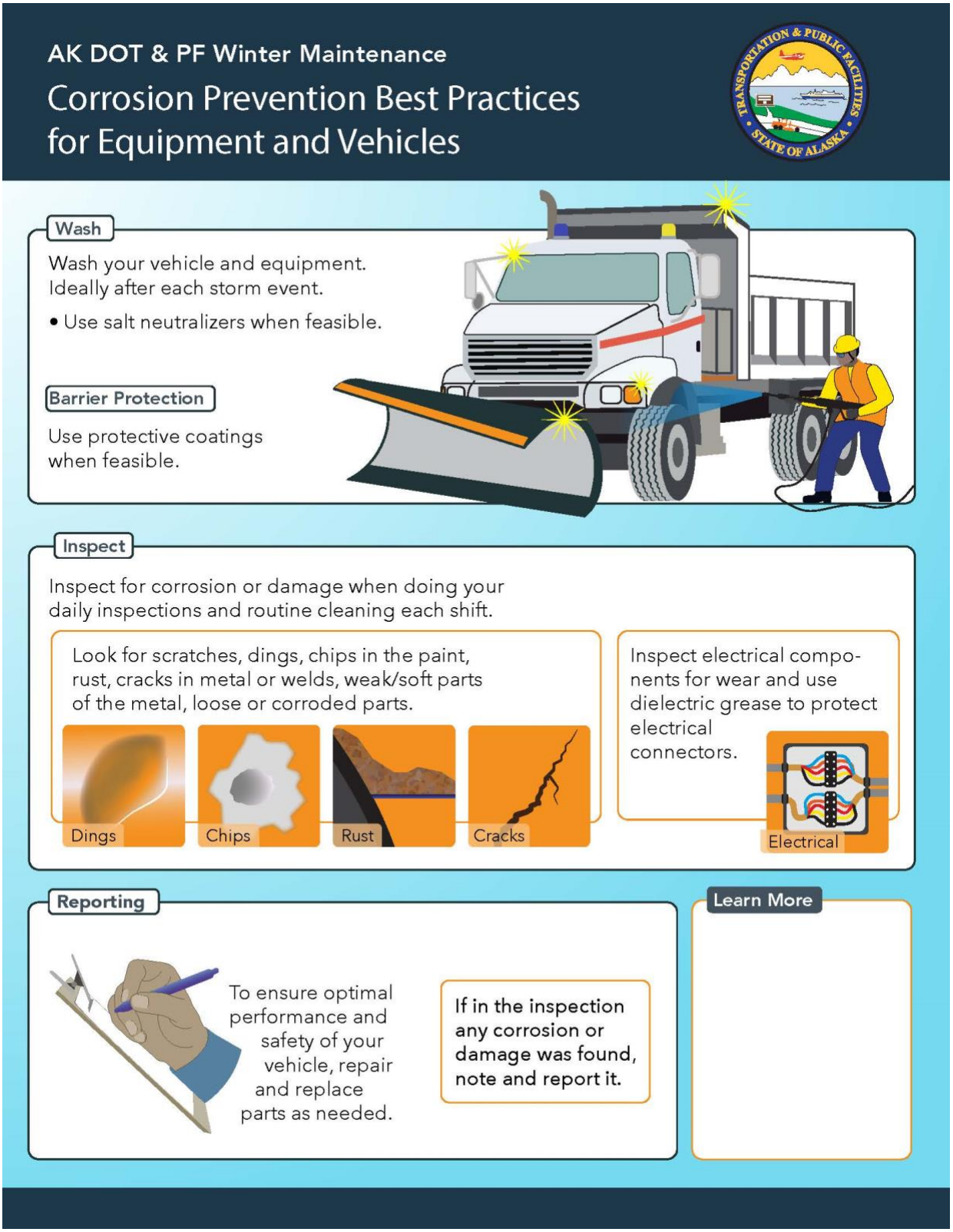

Figure 5. DOT corrosion prevention best practices fact sheet.

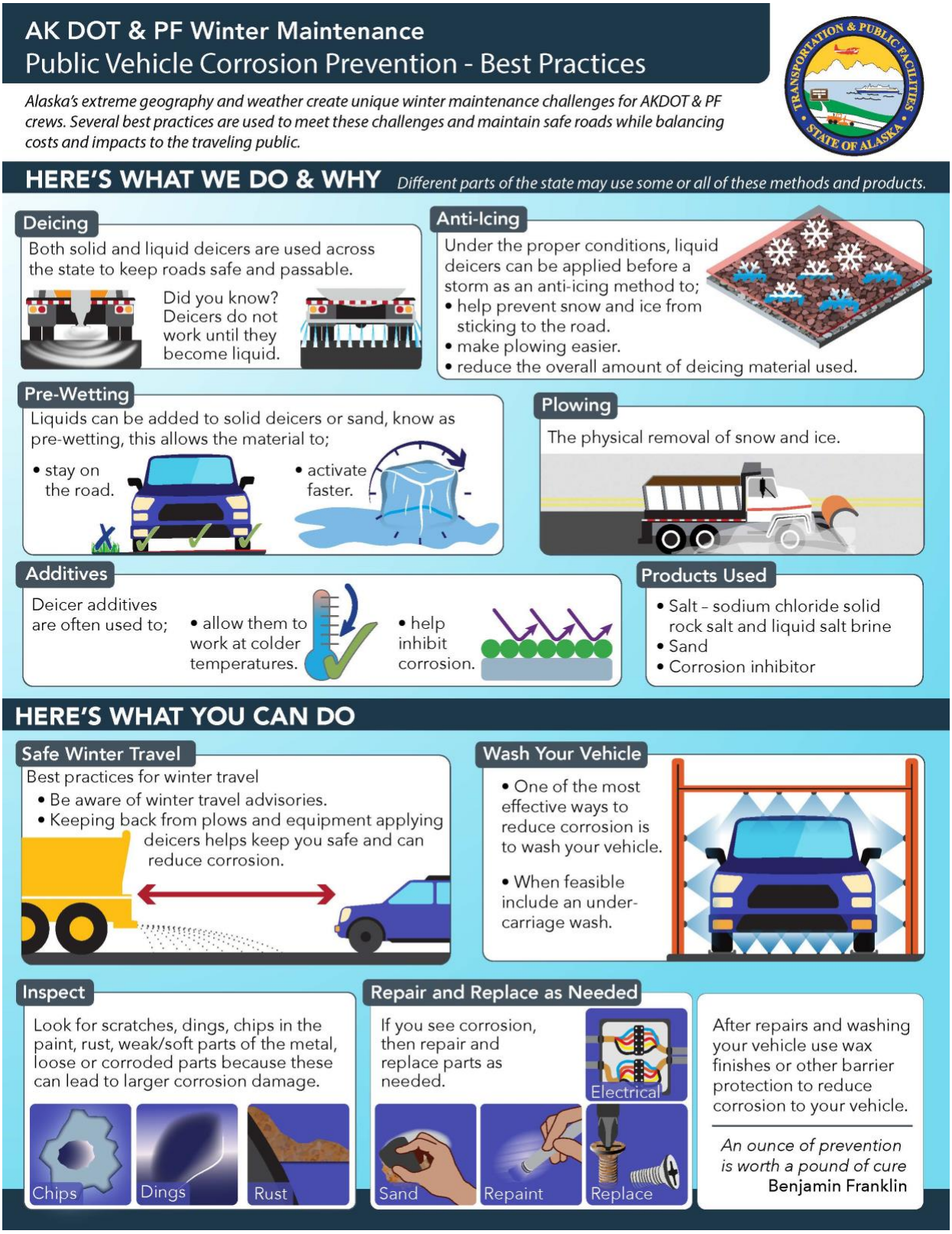

Figure 6. Public vehicle corrosion prevention best practices fact sheet.

CHAPTER 3: INTERPRETATION, APPRAISALS, AND APPLICATIONS

General Recommendations

The following recommendations for AKDOT & PF were developed as a part of this effort.

- Collect detailed data on costs related to corrosion at AKDOT & PF, including costs associated with:
    - Washing—wash bays, water, wands, etc.
    - Salt neutralizers
    - Corrosion inhibitors
    - Anti-corrosion coatings, dielectric grease
    - Vehicle and equipment repairs
    - Premature parts replacement and or more expensive corrosion-resistant part procurement
    - Vehicle and equipment modifications to reduce corrosion
    - Vehicle down time
    - Reduced service life
- Test the corrosion performance of inhibitors in the concentrations at which they are blended. For example, GLT 3-5%. Often, corrosion data reported is based on higher concentrations.
- Design future maintenance facilities to include indoor, drive-through wash bays that allow truck washing and drying in winter months.
- Develop, implement, and train to a routine vehicle and equipment inspection plan that proactively mitigates corrosion.
- Develop a training program specifically for corrosion prevention and reduction.
- Communicate with the public about potential corrosion concerns and the BMPs used to prevent and reduce corrosion to their personal vehicles.

CHAPTER 4: CONCLUSIONS AND SUGGESTED RESEARCH

Conclusions

Alaska DOT & PF uses many deicer types and winter operations methods to provide safe and passable roads in winter conditions. Chloride-based deicers, commonly used by all state DOTs, including Alaska, are known to cause many types of corrosion that result in damage to vehicles, equipment, and infrastructure. Corrosion of vehicles and equipment adds additional costs to agencies and individuals for vehicle and equipment repairs.

Many BMPs have been shown to prevent or reduce corrosion to vehicles and equipment. These include washing, using salt neutralizers in the washing process, using corrosion inhibitors in deicers, using anti-corrosion barriers, and modifying equipment and vehicle design to prevent spot corrosion. Spending time and investing in proactive corrosion prevention has been shown to be more cost effective than reactive corrosion maintenance. When these BMPs are paired with training, agency-wide cost savings of 30%, as well as lengthened vehicle and equipment life, can be realized.

Suggested Research

Future research for the state of Alaska could investigate a region-based cost-benefit analysis of corrosion to the DOT fleet. Additional research could look at region focused field studies of corrosion.

REFERENCES

AAA (America Automobile Association). (2017). Fact Sheet: Road de-icers and rust-related vehicle damage. Newsroom.AAA.com

AHMCT Research Center. (2018) Workshop on Corrosion Protection Technology for Winter Maintenance – A Summary. California Department of Transportation, Sacramento, CA. Accessed February 5, 2024

Anastasio, S., Hoff, I., Thodesen, C. (2015) Influence of sodium chloride and potassium formate as deicing agents on asphalt mixture durability. Bituminous Mixtures and Pavements VI DOI: 10.1201/b18538-70

Casey, P. C., Alwan, C. W., Kline, C. F., Landgraf, G. K., & Linsenmayer, K. R. (2014). Impacts of Using Salt and Salt Brine for Roadway Deicing.

CTC & Associates LLC. (2016) Snowplow Truck Washington Practices: Synthesis Report. Clear Roads Pooled Fund, St. Paul, MN.

CTC & Assoc. (2023) Avoiding Corrosion of Electrical Connectors on Winter Maintenance Equipment. Clear Roads and MnDOT. CR22-S1.

Jamal, M. M. & Shi, X. (2024) Update to CR 13-04: Best Practices for Protecting DOT Equipment from the Corrosion Effect of Chemical Deicers. Clear Roads Pooled Fund, Minnesota Department of Transportation, St. Paul, MN.

Jungwirth, S., Shi, X., Seeley, N., & Fang, Y. (2016). Proactive Approaches to Protecting Maintenance Equipment against Chloride Roadway Deicers. Journal of Cold Regions Engineering, 30(1).

Li, Y., Fang, Y., Seeley, N., Jungwirth, S., Jackson, E., & Shi, X. (2013). Corrosion by chloride deicers on highway maintenance equipment: Renewed perspective and laboratory investigation. Transportation research record, 2361(1), 106-113.

Monty, C. N., Miller, C. M., Schneider, I. V., William, H., & Rodriguez, A. (2014). Evaluation of the effectiveness of salt neutralizers for washing snow and ice equipment (No. FHWA/OH-2013/18). Ohio. Dept. of Transportation. Office of Statewide Planning and Research.

(Nazari) Mehdi, H.N., Bergner, D., Shi, X., and Fay, L. (2015) Best Practices for the Prevention of Corrosion of Department of Transportation Equipment: A User's Manual. Clear Roads Pooled Fund, St. Paul, MN.

Nazari, M. H., Shi, X. (2018). Vehicle risks of winter road operations and best management practices. *Sustainable winter road operations*, 241-272.

Nazari, M.H., Shi, X. (2022) Deicer corrosion of trucks: a case study. Material Performance. November 1, 2022.

Nilsson, F. (2003). Durability problems on Nordic airfields- The influence of deicing agents on asphalt concrete, in: The XXIInd PIARC World Road Congress, 2003.

Pan, T., He, X., Shi, X. (2008). Laboratory investigation of acetate-based deicing/anti-icing agents deteriorating airfield asphalt concrete. Asphalt Paving Technol. -Proc., 77, pp. 773-793.

Rendahl, B., Hedlund, S. (1992) The influence of road deicing salts on motor vehicle corrosion. Corrosion 1992, Symposium "Automotive Corrosion and Protection", Houston, TX: NACE.

Rodriquez, A.A., Miller, C.M., Monty, C.N. (2020) Field testing and cost-benefit evaluation of corrosion-protective coatings on winter maintenance equipment in the state of Ohio. Journal of Cold Regions Engineering 35(1).

Rubin, J., Garder, P. E., Morris, C. E., Nichols, K. L., Peckenham, J., McKee, P., ... & Johnson, T. O. (2010). Maine's Winter Roads: Salt, Safety, Environment and Cost.

Shi, X. (2008). Impact of airport pavement deicing products on aircraft and airfield infrastructure (Vol. 6). Transportation Research Board, Washington, D.C.

Shi, X., Li, Y., Jungwirth, S., Fang, Y., Seeley, N., Jackson, E. (2013) Identification and laboratory assessment of best practices to protect DOT equipment from corrosive effect of chemical deicers. Washington State DOT. WA-RD- 796.1

Shi, X., Fay, L., Yang, Z., Nguyen, T.A., Liu, Y. (2009a). Corrosion of deicers to metal in transportation infrastructure: introduction and recent developments. Corrosion Review 27: 23-52.

Shi, X., Fay, L., Gallaway, C., Volkening, K., Peterson, M.M., Pan, T., Creighton, A., Lawlor, C., Mumma, S., Liu, Y., Nguyen, T.A. (2009b) Evaluation of alternative anti-icing and deicing compounds using sodium chloride and magnesium chloride as baseline deicers. Colorado DOT, CDOT-2009-1

Qian et al. (2015) The Application of Anti-Corrosion Coating for Preserving the Value of Equipment Asset in Chloride-Laden Environments: A Review. International Journal of Electrochemical Science, 10: 10756-10780

Vitaliano, D.F. (1992) An economic assessment of the social costs of highway salting and the efficiency of substituting a new deicing material. Journal of Policy Analysis and Management, Summer 11(3): 397-418.

Wood, D.O. (1976) Motor-vehicle corrosion from deicing salt. Transportation Research Record, 762: 32-36

Xie, N., Shi, X., & Zhang, Y. (2017). “Impacts of Potassium Acetate and Sodium-Chloride Deicers on Concrete.” Journal of Materials in Civil Engineering, 29 (3): 04016229. American Society of Civil Engineers. https://doi.org/10.1061/(ASCE)MT.1943-5533.0001754.

APPENDIX A: SURVEY INSTRUMENT

Survey Questionnaire

Corrosion Concerns in Alaska from the Use of Deicers

Contact Information

Name:

Job Title:

Region:

Deicer and Anti-Icer Use

Please respond to the following questions with as much detail as is possible. Product names are preferred, but If you are blending products, please provide the name of the products used and percentages (for example, salt brine with 8% beet juice).

- Which deicer(s) (liquid or solid), dust control product(s), and additive(s) do you use in your region on the following facilities?
    - DOT Roads:
    - Local Roads (paved):
    - Local Roads (unpaved):
    - Pedestrian Facilities:
    - Airports:
    - Private Landowners – parking lots, sidewalks, etc. [This may not apply to you]:
- How are deicers applied in your region? (Circle all that apply)
    - Solid
    - pre-wet solid
    - Liquid
    - Other, please explain.
    - Application Rate – this will likely vary by temperature and conditions. Be as specific as possible.
    - Under what conditions do you use each product?
    - Are there specific locations for certain products? Such as bridges, common crash areas, etc.
    - Feel free to explain why you do specific things.

- Has your region identified any concerns about corrosion to personal, fleet, and commercial vehicles?
    - Yes (please explain) or No
    - Common parts that corrode?
    - Has your region received complaints or concerns from the public related to corrosion of vehicles?
- Does your region utilize any of the following best management practices (BMPs) to reduce or prevent corrosion to vehicles? (Circle all that apply)
    - Use a corrosion inhibitor in your deicers,
    - Wash vehicles,
    - Use a salt neutralizer,
    - Others? Please explain.
- Please provide a link or email your Level of Service guidelines to Laura Fay (laura.fay1@montana.edu).
- Please provide a link or email your winter maintenance operations plan to Laura Fay (laura.fay1@montana.edu).

Once completed please send to cristina.demattio@alaska.gov and laura.fay1@montana.edu.