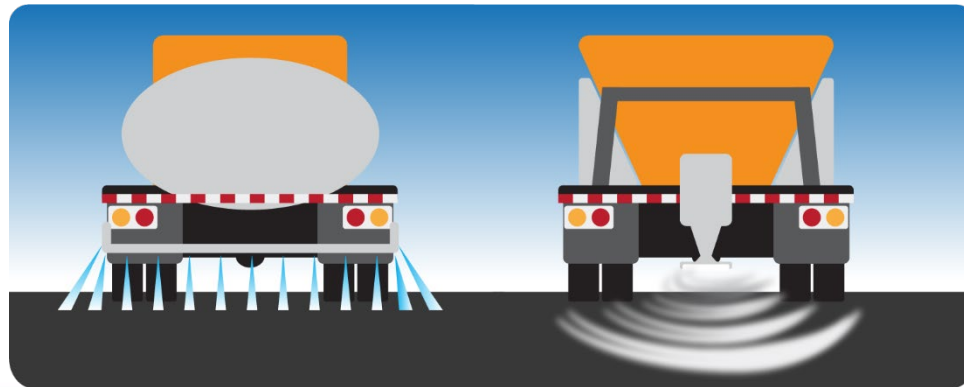


# You have a corrosion problem, now what?

Laura Fay  
October 2024

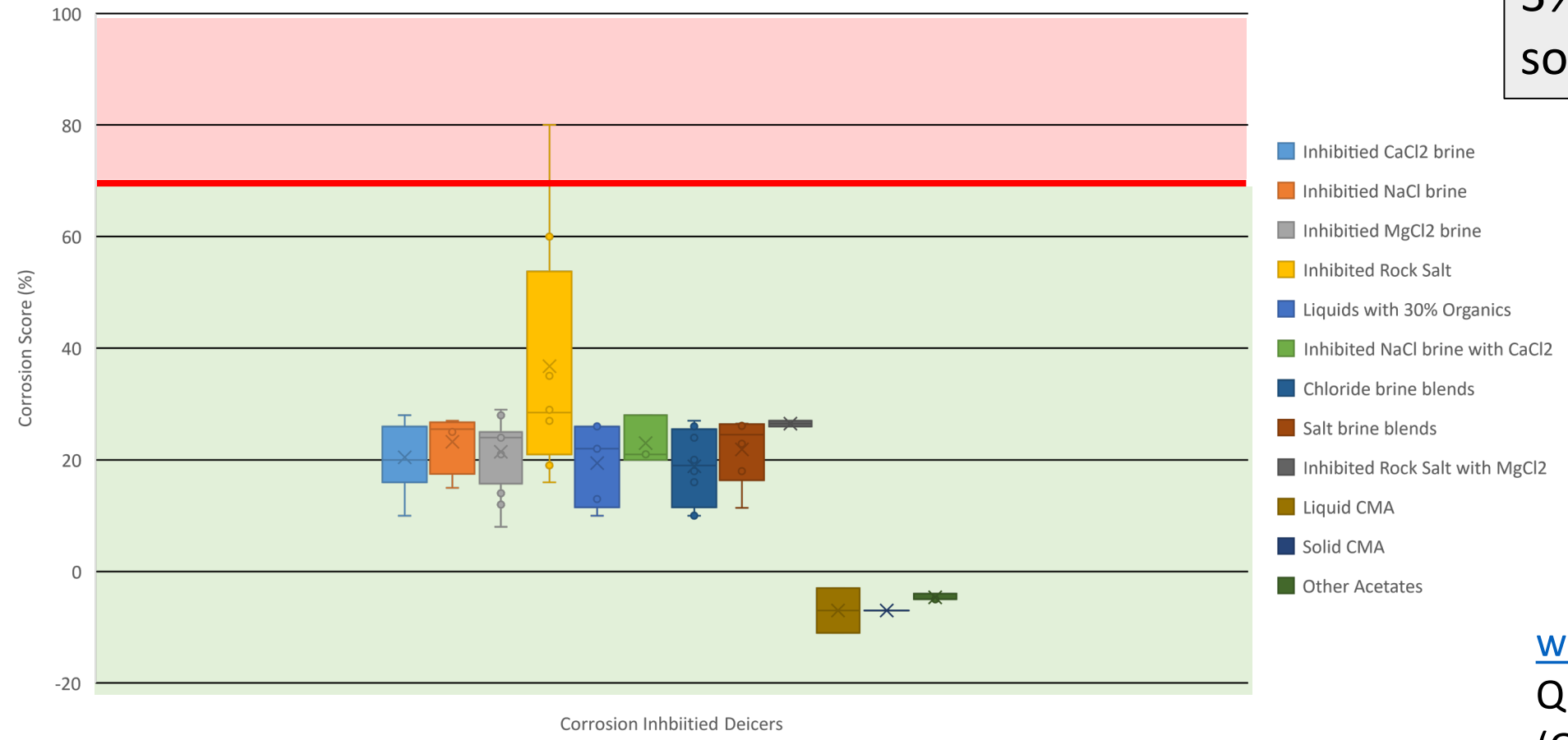
## What are you using, seeing, doing in Michigan

- What solids and liquids are you using?
- What are your application rates?
- What types of and where are you seeing corrosion?
- What best practices are you currently using to prevent corrosion?



## Reported Corrosion Scores

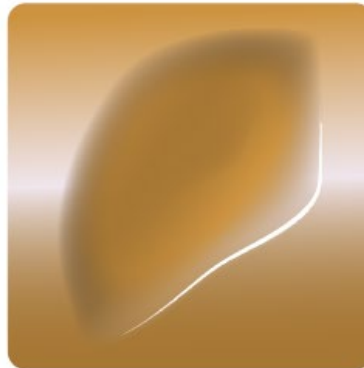
Passing = 70% less corrosive than a 3% salt brine solution



[www.clearroad.org](http://www.clearroad.org)  
Qualified Product List (QPL)

## Corrosion from Deicers

- Corrosion caused by chloride-based deicers can impact equipment, vehicles, and infrastructure.
- Common forms of corrosion: Pitting
  - Filiform
  - Crevice
  - Intergranular
  - Galvanic
  - Stress cracking
  - Fatigue
  - Erosion
  - Fretting
  - Microbially induced



## Corrosion from Deicers

- Modern vehicles are made of many metal types and alloys, which can exacerbate corrosion.
- The most commonly used and cost-effective deicers used to keep roads safe and passible contain chlorides, which cause corrosion.
- But all deicers have impacts, in fact metals and roadways have been shown to be impacted by common non-chloride deicers, but to a lesser extent.

## Cost of Corrosion

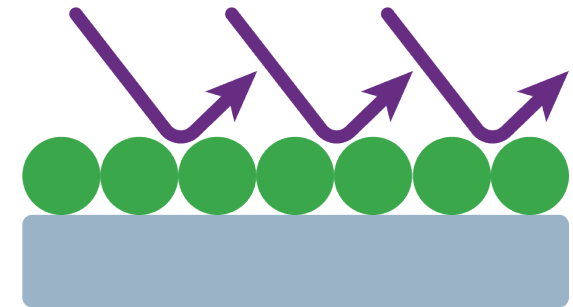
- DOTs report corrosion costs of \$1M to \$14M annually, or about 4% - 9% of the annual repair budgets.
- Up to 30% of these costs may be avoided with proactive corrosion prevention.
  - Anti-corrosion coatings, washing with hot water at low pressure, and vehicle design considerations.
- Corrosion leads to about 17% reduction in equipment service life, or loss of 3 years of service.
- To reach design life requires more frequent replacement of parts or with parts that are more costly and have corrosion protection.

## Cost of Corrosion

- Corrosion damage to vehicles and equipment is not just rusting:
  - Depreciation and down time, reduced reliability, reduced service life, premature repairs and replacement, and safety risks from corroded parts.
- All data on corrosion costs to personal vehicles is 7 - 32 years old. Needs to be updated with current cost information!
- A Scandinavian study found 50% reduction in vehicle corrosion on salt-free roads.

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

- Proactive measure to prevent corrosion include
  - Barrier protection (inhibitive coatings, anti-corrosion coatings)
  - Galvanization
  - Cathodic protection
  - Washing vehicles and equipment
  - Use of salt neutralizers
  - Corrective methods (dielectric grease, etc.)
  - Design considerations





## Anti-Corrosion Coatings

Anti-corrosion coatings can be extremely effective at reducing corrosion, but performance varies for each product.

Proper surface preparation is important

- Use a salt neutralizer, or grit or sand blast the surface
- Then apply coating
- Thicker coatings last longer

## Anti-Corrosion Coatings

- Anti-corrosion coatings may be barrier protection, inhibitive or protective coatings, anodically active metal coatings, or salt removers.
  - Barrier protection prevents oxygen, water, salt, and debris from reaching the vehicle or equipment surface.
  - Inhibitive coatings alter the surface chemistry.
  - Anodic coating, usually made of zinc, prevent electrical current from discharging from the metallic surface.
  - Metallic coatings, usually zinc or zinc-alloys, serve as both a barrier and provide cathodic protection.
- Anti-corrosion treatments to vehicles used to be better! But Hexavalent Chromium is very toxic and no longer used.



## Anti-Corrosion Coatings

Product	Company	Description	Estimated Price	Link
<b>Cavity Wax</b>	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	<a href="https://www.3m.com/3M/en_US/p/d/b40066669/">https://www.3m.com/3M/en_US/p/d/b40066669/</a>
<b>Weld-Thru Coating</b>	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	<a href="https://www.3m.com/3M/en_US/p/d/v000056390/">https://www.3m.com/3M/en_US/p/d/v000056390/</a>
<b>Carwell Rust Inhibitor CP90</b>	Carwell Corrosion Control	Carwell Rust Inhibitor is a clear liquid blend of rust inhibitors that creates an active barrier to repel salt and moisture, 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	<a href="https://www.carwell.com/product/t32-cp90-1-gallon-jug/">https://www.carwell.com/product/t32-cp90-1-gallon-jug/</a>
<b>CorrBarrier Primer</b>	Cortec	CorrBarrier Primer is a water-based, one-coat system for underbody/under-hood protection.	Not available	<a href="https://www.cortecoatings.com/product/corrbarrier/">https://www.cortecoatings.com/product/corrbarrier/</a>
<b>VpCI-398</b>	Cortec	VpCI-398 is a solvent-based sulphonate one-coat system which can be applied directly to metal.	\$87 per gallon	<a href="https://www.cortecoatings.com/product/vpci-398/">https://www.cortecoatings.com/product/vpci-398/</a>
<b>Nox-Rust 4490, Nox-Rust 4495</b>	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 1-2 gallons per vehicle)	<a href="https://www.daubertchemical.com/coatings/automotive-transportation/annual-rust-proofing-underbody/">https://www.daubertchemical.com/coatings/automotive-transportation/annual-rust-proofing-underbody/</a>

Product	Company	Description	Estimated Price	Link
<b>Fluid Film</b>	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	<a href="https://www.fluid-film.com/">https://www.fluid-film.com/</a>
<b>Zero Rust</b>	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)	<a href="https://www.usezerorust.com/wp-content/uploads/2019/03/2019.Zero_Rust_brochure.pdf">https://www.usezerorust.com/wp-content/uploads/2019/03/2019.Zero_Rust_brochure.pdf</a>
<b>Krown Rust Protection &amp; Lubricants</b>	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	<a href="https://www.krown.com/en/">https://www.krown.com/en/</a>  <a href="https://www.krown.com/en/products/aerosols/rust-protection-lubricants/">https://www.krown.com/en/products/aerosols/rust-protection-lubricants/</a>
<b>Boss Wax and Oil</b>	NHOU Protective Coatings	Boss Wax and Oil is a semi-permanent rust protection for new vehicles.	\$48 per gallon	<a href="https://nhoilundercoating.com/rust-prevention-rustproofing-nhou/">https://nhoilundercoating.com/rust-prevention-rustproofing-nhou/</a>
<b>NH Oil Undercoating</b>	NHOU Protective Coatings	NH Oil Undercoating is an oil-based rust proofing which is applied using high pressure which pushes the coating into seams, cracks, etc. Annual reapplications are recommended.	\$56 per gallon	<a href="https://nhoilundercoating.com/">https://nhoilundercoating.com/</a>

Product	Company	Description	Estimated Price	Link
<b>POR-15 Rust Preventive Coating</b>	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	<a href="https://por15.com/products/rust-preventive-coating?variant=42895337750695">https://por15.com/products/rust-preventive-coating?variant=42895337750695</a>
<b>Aquapon</b>	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	<a href="https://www.ppgpmc.com/products/aquapon-97-670-series">https://www.ppgpmc.com/products/aquapon-97-670-series</a>
<b>ARMOUR-Seal</b>	Rhomar	ARMOUR-Seal is a semi-permanent, professional grade, rubberized undercoating which 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)	<a href="https://rhomar.com/products/armour-seal/">https://rhomar.com/products/armour-seal/</a>
<b>Lubra-Seal</b>	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	<a href="https://rhomar.com/products/lubra-seal/">https://rhomar.com/products/lubra-seal/</a>
<b>Rust Bullet</b>	Rust Bullet, LLC	Rust Bullet is a moisture-cured urethane coating which 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	<a href="https://www.rustbullet.com/product-category/rust-inhibitors/automotive/">https://www.rustbullet.com/product-category/rust-inhibitors/automotive/</a>

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Product	Company	Description	Estimated Price	Link
<b>S2S Automotive Rust Proofing</b>	Ship-2-Shore	S2S Automotive Rust Proofing is a non-tacky coating which 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	<a href="https://ship-2-shore.com/products/commercial-products/automotive-rust-proofing/">https://ship-2-shore.com/products/commercial-products/automotive-rust-proofing/</a>
<b>Undercoating in a Can</b>	Undercoating in a Can	Undercoating in a Can is a wax-based self-healing undercoat for metal and wood surfaces.	\$80.44 per gallon	<a href="https://undercoatinginacan.com/#2">https://undercoatinginacan.com/#2</a>
<b>Undercoating in a Can Clear Fluid Coat</b>	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	<a href="https://undercoatinginacan.com/undercoating-in-a-can-clear-fluid-coat/">https://undercoatinginacan.com/undercoating-in-a-can-clear-fluid-coat/</a>
<b>Undercoating in a Can Rubberized</b>	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	<a href="https://undercoatinginacan.com/#2">https://undercoatinginacan.com/#2</a>
<b>ValuGard - Rust Prevention</b>	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)	<a href="https://valugard.net/products/rust-prevention-products.html">https://valugard.net/products/rust-prevention-products.html</a>
<b>Z-Guard</b>	Ziebart	Z-Guard is a durable, thixotropic, corrosion-preventative undercoating for underbody components. Z-Guard is applied using airless spray equipment.	\$29 per quart	<a href="https://petroleumservicecompany.com/z-guard-8000-undercoating/">https://petroleumservicecompany.com/z-guard-8000-undercoating/</a>

## Washing Vehicles & Equipment to Prevent Corrosion

Washing your vehicle, work or personal, and equipment regularly can prevent corrosion from causing serious damage to components.

	Ideal Washing Frequency	Realistic Washing Frequency
Plow Truck and Equipment	Daily after each use	Weekly
Personal Vehicles	Once a week or after each storm event	Monthly, when feasible

## Salt Neutralizers & Salt Inhibitors

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

- The performance of salt neutralizers is affected by the dilution rate.
  - Perform better at higher concentrations, but this costs more.
- To maximize effectiveness, wash with soap and water first, then use salt neutralizer in targeted areas of concern.
  - This method uses ~100 gal per truck, instead of 350 gal.
  - Specific recommendation for one product (Salt-Away).



## Salt Neutralizers & Salt Inhibitors

Product	Company	Description	Estimated Price	Link
AGS Rust Solutions, Salt Neutralizer Concentrate	AGS Rust Solutions	AGS Rust Solutions Concentrate is a salt neutralizer which is safe to use on any metal surface exposed to road salt. This concentrate can be used to make over twenty gallons of neutralizer and is easily applied using a spray-on, wipe-off process.	\$39.99 per gallon	<a href="https://rustsolutions.com/products/salt-neutralizer-gallon">https://rustsolutions.com/products/salt-neutralizer-gallon</a>
Salt Kleen	Bio Kleen	Salt Kleen is a salt neutralizer which is applied and rinsed away with water to remove salt debris.	\$31.95 per gallon	<a href="https://www.biokleen.com/salt-neutralizer">https://www.biokleen.com/salt-neutralizer</a>
ConSALT	EaCo Chem	ConSALT removes corrosive and harmful salts that build up on road equipment and helps prevent damage to the painted surfaces. ConSALT can also be used to clean out brine tanks and lines to prevent corrosive salt build-ups.	Not available	<a href="https://eacochem.com/eaco_products/product_consalt/">https://eacochem.com/eaco_products/product_consalt/</a>
Eastwood Road Salt Neutralizer	Eastwood	Eastwood Road Safety Neutralizer is a salt neutralizer which is mixed with water and hosed off to clean metal substrates exposed to road salt.	\$28.97 per gallon	<a href="https://www.eastwood.com/eastwood-road-salt-neutralizer-gallon.html">https://www.eastwood.com/eastwood-road-salt-neutralizer-gallon.html</a>
Salt Brine Eliminator	NHOU Protective Coatings	Salt Brine Eliminator is a salt remover designed for heavy duty applications.	\$50-\$200	<a href="https://nhoilundercoating.com/product/nhou-salt-brine-eliminator/">https://nhoilundercoating.com/product/nhou-salt-brine-eliminator/</a>
NEUTRO-WASH	Rhomar	NEUTRO-WASH was developed to eliminate rust & corrosion damage to public works trucks and salt spreaders by removing the corrosive chemicals used to deice roadways. No complicated process, wash your 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	<a href="https://rhomar.com/products/neutro-wash/">https://rhomar.com/products/neutro-wash/</a>
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.	\$48.00 per gallon	<a href="https://www.saltaway.com/">https://www.saltaway.com/</a>

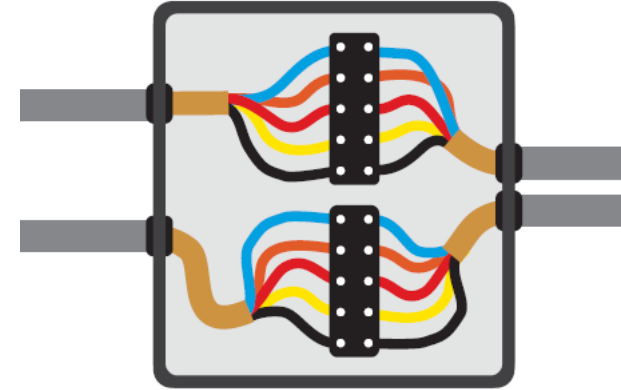
## Reducing Corrosion with Design

There are vehicle and equipment design considerations that can reduce corrosion.

- Avoid areas that track or accumulate liquids
- Provide easy drainage
- Minimize welding joints and gaskets
- Avoid cervices, specifically between dissimilar metal alloys
- Locate equipment to allow for easy access for maintenance and repair/painting
- Metal type matters – carbon steel and cast irons experience higher corrosion rates

## Reducing Corrosion to Electrical Components

- Waterproof or weather connectors
- Clean connectors frequently
- Use dielectric silicone or grease for sealing connections
- Apply heat tubing to cover crimped areas
- Relocate junction boxes inside the cab and off the floor of the vehicle
- Use continuous wiring to minimize the number of connectors



- 
- Other less common or newer options:
    - Anti-corrosion coatings for aluminum wiring, graphene coatings for metallic connectors and electrical terminals, connectors designed specifically for corrosive environments, using molded plastics for housings, self healing coatings and lubricants.

## Other Design Considerations

- Cut a 1 inch hole in truck beds to allow for air circulation/drying out the vehicle frame (Ohio DOT)
- Paint or coat drilled/cut edges
- Purchase replacement parts as needed and made of more corrosion resistant materials or with coatings
- Weld off or seal areas that do not drain well, caulk welds before painting/coating, inject polyurethane foam into cavities, use underbody splash shields.
- Use continuous welds

## Cost of Corrosion Prevention

Investment in proactive maintenance and training to prevent corrosion is more cost-effective than reactive maintenance.

- ~20% of corrosion related costs could be reduced with implementation of an equipment corrosion management plan and proactive maintenance.
- Protective coatings increase equipment service life and reduce maintenance costs.

## Conclusions

There will be corrosion, it comes down to how we handle it!

Best practices to reduce corrosion to vehicles and equipment may cost a little extra time and money but can provide cost saving and reduce corrosion in long run.

## Conclusions

- DOT Best Practices to reduce or prevent corrosion
  - Be proactive, not reactive
  - Implement a proactive fleet management plan that considers corrosion prevention
  - Implement corrosion-related training
  - Routine inspection of equipment and vehicles for corrosion damage
  - Avoid equipment designs that are susceptible to corrosion
  - 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 corrosion causing materials
  - Use protective or sacrificial coatings

## Conclusions/Recommendations

- Most corrosion cost data is significantly outdated.
  - Collect data related to corrosion costs and corrosion prevention to allow for a cost-benefit analysis to be conducted on various strategies.
- Consider testing corrosion inhibitors used at blended concentration.
- Consider future maintenance facility design to include indoor, drive-through wash bays to allow for equipment/truck washing and drying in winter months.
- Develop, train, and implement a routine vehicle and equipment inspection plan to proactively mitigate corrosion.



## Questions?

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## Resources

[Corrosion and Connectors Don't Mix](#)

[Corrosion Best Practices for DOTs](#)  
(Updated)