The Monster That's Eating Your Rigs

Dealing with road salt and corrosion is nothing new to Chuck Diehl, fleet manager for Smith's Dairy in Orrville, Ohio. Considering the company's location in the northeast part of the state, "It's always been something that's part of our environment," he says, especially with the 10- to 12-year life cycle they expect out of their equipment.

"But in the last three years, now that the state of Ohio is using the new liquid de-icers, we have definitely seen this accelerated," he says. "It's been amazing to watch to see how it's attacking anything that's metal. If it's anything that's mild steel and it's not properly prepared and coated or treated, you can kiss it goodbye in just a couple of years."

Frame rails, crossmembers, suspension components, air tanks, fuel tanks, battery boxes, brackets, brake shoes, electrical systems, air-conditioning condensers, radiators, metal coolant tubing, steel wheels, inside the floor of the cab - even refrigeration units aren't safe from the corrosion monster, Diehl says. "It has really changed our thinking and how we approach treating all those metal surfaces."

Diehl is not alone. The problem has become so pervasive, the Technology and Maintenance Council of the American Trucking Associations set up a Corrosion Control Action Committee, which had its first meeting during TMC's Fall Meeting in Nashville in September. The committee's goal is to coordinate with TMC's many study groups to develop recommended practices for equipment manufacturers and fleets to prevent corrosion problems.

TMC has calculated some estimates of what corrosion is costing the industry, based on a 2004 survey of fleets and available statistics on the number of commercial vehicles.

If you assume that during a four-year period, each of the 2.35 million Class 6-8 commercial vehicles in the country has to have its wiring, two sets of brake shoes and drums, lights, a fuel tank, a radiator and a mirror bracket replaced, you're looking at $2.4 billion to $4 billion a year. That doesn't even take into account trailer corrosion costs, the costs of frequent washings, or the cost of road calls - and 63 percent of the fleets responding to the TMC survey said they had experienced road calls due to corrosion.

The Chemistry Of Corrosion

At issue are the new liquid de-icers that have become a common weapon in highway agencies' battle against snow and ice - magnesium chloride and calcium chloride. When sprayed on pavement in advance of a coming storm, these chemicals can prevent ice from forming on the roadways, making snow removal easier and in some cases keeping the pavement clear.

"This stuff costs about a third less than those big mounds of salt you see, and it's safe to put on because you can put it down before the snow hits, and it really doesn't evaporate," says Travis Hopkey, director of marketing at Phillips Industries. "So it sticks around and melts the snow - but it also turns into a fine mist and gets everywhere. Any exposed material or exposed connection - the whole truck and trailer gets coated in this fine mist, and it seeps into tiny little crevices and cracks and starts to work its magic."

Some of the properties that make these chemicals so good at keeping roads clear are the same characteristics that make them so destructive.

For one thing, as Hopkey notes, calcium and magnesium chloride are highly soluble in water, so they produce a finer mist of spray under the vehicle than old-fashioned rock salt does.

Mac Whittemore, regional manager with ArvinMeritor, explained the situation at TMC's corrosion committee presentation. "Because this spray is finer, it starts penetrating into areas where you wouldn't necessarily think it can get to - underneath the paint, inside the brakes."

Both these chemicals are hygroscopic, which means they will absorb moisture from any source. In fact, they are also commonly used as desiccants, and for dust control on rural roadways. If you put a chunk of dry magnesium or calcium chloride on a table in a laboratory environment and leave it overnight, when you come back, it will have a puddle of water around it that it has absorbed from the air.

This means that even when the weather and your equipment are dry, the chemicals continue to attract moisture. They easily mix with the water they attract and then seep into the tiniest cracks. Recent reports even have found corrosion seeping into the air brake system.

It's unlikely that highway departments will stop using something that has proven to be such an effective lifesaver.

However, there have been some concerns from other corners besides the trucking industry. Some studies seem to show these de-icing salts cause concrete to deteriorate more rapidly, and electrical utilities have reported corrosion of power poles as well as electrical shorts.

There are corrosion inhibitors and other buffers that can be added to these chemicals, but costs and problems with handling have meant slow adoption. Washington and Idaho have pioneered programs to limit corrosion through strict specification on the corrosiveness of de-icing chemicals, and other states and provinces are exploring its use, according to Morris Chemicals, which markets calcium chloride.

What Equipment Manufacturers Are Doing

Manufacturers of trucks, trailers and various components have been working to develop more corrosion-resistant products. Some examples from this year alone:

• Isuzu's new N-Series for 2008 touts greater corrosion protection, from the galvanized steel panels to the electro deposit paint primer and high-quality enamel paint topcoat.

• Great Dane Trailers introduced a package of corrosion prevention solutions featuring CorroGuard, a spray-in-place thermoplastic elastomer coating applied to suspensions and support gear.

• When Freightliner introduced the Cascadia, it touted corrosion protection for fasteners.

• ArvinMeritor's RideSentry trailer suspension with a new PinLoc slider locking mechanism featured an e-coat protected slider.

• Hendrickson's latest InTraax trailer suspension uses patented Tri-Functional III Bushings with phosphate-coated inner metal for corrosion protection.

At TMC, Whittemore talked about the research ArvinMeritor has been doing to try to develop corrosion-resistant brakes. "Rust jacking" on brakes was one of the first

clues the trucking industry had that there was a corrosion problem. This happens when corrosion develops between the brake shoe table and the brake lining. Because rust has a higher volume than the originating mass of iron, its buildup can force adjacent parts apart. This causes the lining to lift and crack. On a rust-jacked brake shoe, rivets will still be holding part of the lining to the shoe, but in between the rivets, it's cracked.

ArvinMeritor has been testing paints, e-coatings, ceramics, pre-treatments, and adhesives that seal the area between the brake shoe table and the lining. A full-time program manager heads its rust jacking prevention efforts. The most promising approach, Whittemore said, is a process of applying an adhesive membrane between a new shoe table and the lining material. This heat-activated material would melt under the application of the brakes in the real world, sealing the lining to the brake shoe. The problem is, once the adhesive membrane has set up, that brake shoe cannot be re-lined. They also don't know at this point what kind of a price premium this technology would demand.

One important step to help manufacturers develop equipment and treatments that will better resist corrosion is a laboratory test that can accurately simulate the effects of these de-icers. In the past, a standard from the testing-standards organization ASTM, B117, commonly called the salt spray test, has been the industry standard for testing corrosion resistance. But this test has not been very accurate at predicting real-world performance with today's de-icers.

"We're finding out that extending the time in the salt spray chambers was not correlating with actual field test data," said Brad Van Riper, senior vice president and chief technology officer for Truck-Lite, in a presentation to the TMC corrosion committee. "Five years ago we were doing 240 hours (in the salt spray chamber) at Truck-Lite. We moved to 1,000 hours, but 1,000 hours of salt spray are not satisfying the customer and they're not correlating well with the field experience." In other words, components may be lasting five times as long in the salt spray chamber, but they're not lasting that much longer in the real world.

"We've got to have a way to measure ourselves to improve," Van Riper said. "Having a good test in place seems like the first step."

Van Riper is on the corrosion task force of the Society of Automotive Engineers that has been working for several years to develop a more accurate test, known as SAE J2721. In addition to actually using the new de-icers rather than just traditional road salt, one of the key differences in this test will be using a cycle of conditions - for instance, a body exterior might go through cycles featuring a wet soak, a salt application, then a dry soak.

"On the (current) salt spray test, we're only seeing a wet period, and we know that wetting and drying of the corrosive materials can contribute to accelerated corrosion," Van Riper explained.

A test for chassis corrosion resistance would include gravel bombardment and a slurry grit as part of the cycle. "The point is, we're exposing the components to much different corrosion qualifying tests than has ever been done before."

The proposed standards would provide criteria for whether the component passes the test, including standards for cosmetic corrosion, functional corrosion, and structural corrosion, including photos to help determine what level of corrosion is present on tested components .

Fleet Strategies

There are an increasing number of options you can spec when buying a truck to help prevent corrosion. Only you can make the determination on whether they provide an effective return on investment in your operation.

The electrical system is one area that is particularly vulnerable, and with increasing use of electronics on vehicles, it's more critical than ever to keep corrosion at bay. As the electrical system is powered and unpowered, and wires heat up, they expand. When they contract, they draw in the air around them - and contaminants and moisture.

Phillips Industries spotted a corrosion problem in electrical components soon after the dawn of the new millennium. "We were starting to see more returns, and they were really nasty returns, stuff we'd never seen before, and failing a lot faster than ever before," Hopkey says. "Fleets should look for products that are specifically built to resist corrosion. We've got everything from plugs and sockets to gladhands."

And corrosion protection is not necessarily expensive. Little details can make a big difference. For instance, Hopkey says, the seven-way connector's design inherently lets in moisture. Phillips now offers a foam socket insert that slides over the pins in the seven-way connector socket into the base to seal out moisture.

Any time a tractor or trailer is repaired, use a heat shrink terminal that seals out moisture. The old nylon and PVC terminals are unsealed, easily allowing contaminants inside.

When it comes to maintenance, washing vehicles to try to keep the chemicals off the metal is important. There is no clear answer to the question of what washing strategies are best. Pressure washing may only push the chemical mixture further into tiny cracks and crevices. In addition, the new chlorides tend to stick to surfaces more than traditional road salt, and may need physical action to get them off rather than just spraying them with wash water. Keep in mind that more cleaning liquid is not necessarily better - in some cases, an over-concentration of washing compound may actually attack some of the plastics that are there to provide corrosion resistance.

A new area where fleets are reporting corrosion, according to several people at the TMC fall meeting, is the air system - the control ports of air brake valves are developing corrosion.

"This stuff is migrating deeper into the vehicle than we've ever seen before," Whittemore said. "It's getting into the air systems. That corrosive material can get inside the lines, inside the tanks. The inside of a valve fitting isn't expected to be coated with an anti-corrosion coating, at least not yet." That means it's more critical than ever to maintain the air driers and keep water drained from the system.

Hopkey recommends using gladhand seals with dust flaps, which keep contaminants out of the system when the trailer is untethered. Otherwise, it's very easy for rainwater to become contaminated with the chlorides on the trailer surfaces and creep into the air system.

At Smith's Dairy, Diehl says, they have stopped buying used equipment that has been operated north of the Mason-Dixon line. They recently bought some three-year-old tractors from a major leasing company, but found so much rust and corrosion on the frames that they decided to take them down to the bare frame rails and re-paint - something they normally do about midway through their equipment's 10- to 12-year life cycle. "The rules of the game have changed," Diehl says. "The bar has been raised for us and how we're going to face this corrosion and rust that we're encountering."

Killer Chemicals

Chemicals used to de-ice roads are still wreaking havoc with critical truck components. Here's what you can do to protect vehicles from corrosion.

Deborah Lockridge
Senior Editor

A 3-year-old wheel from an Iowa DOT snowplow. A 3-year-old muffler inlet elbow. A 4-year-old air spring base. A 15-year-old trailer pickup-up plate. Seven-year-old trailer crossmembers. A 4-year-old fuel tank. Air tanks. Brake linings. All coated with rust and corrosion, some nearly falling apart.

This was what fleet maintenance managers saw at the February annual meeting of the Technology and Maintenance Council of the American Trucking Assns., during a panel discussion on corrosion prevention.

It's been about five years since fleet managers started comparing notes and realized that new de-icers seemed to be causing never-before-seen corrosion problems. Since then, we've learned that, despite the trucking industry's protests, these chemicals are not likely to go away. We've also learned some of the reasons these chemicals are so aggressive. And the industry is developing new technology and techniques to help prevent corrosion.

Ordinary salt - sodium chloride - has been used to de-ice winter roads since the late 1930s. In the 1990s, road departments discovered new chemicals - magnesium chloride and calcium chloride - that could be sprayed on roads before a storm and lowered the freezing point of water, keeping snow from sticking and ice from forming.

Unfortunately, after several years of having their trucks exposed to these chemicals, truckers realized that there was another big difference: aggressive corrosion of electrical wiring, truck frames, suspension parts, brakes and more.

Despite the trucking industry's efforts to convince state DOTs that these chemicals are harmful, it looks like magnesium chloride and calcium chloride are here to stay.

"There's definitely a higher demand by the public to have the roads cleared quicker, to have them dry faster," says David Alexander, project manager for the Winter Roads Management Program at the University of Idaho, sponsored by the ATA.

"The public doesn't really want to put the chains on anymore. They don't want to slow down for ice. There's a lot of pressure on the state departments of transportation to use these chemicals."

The makers of these salts are working to add corrosion inhibitors to to their product, but so far they seem to be limited in their effects.

"There's going to be corrosion, and there has to be a certain level of compromise," Alexander says. "I don't think it's reasonable to expect 25 years out of a vehicle without any corrosion damage, but where's the line? What's a reasonable lifetime for the parts, and who's going to make that decision?"

When The Holland Group started looking into corrosion in 1991, it wanted to find out what the industry was looking for in terms of performance. "We really found there's not a real strong industry consensus about what they want. They just know there's a problem," says Steve Dupay, director of research and development.

TMC's Future Truck project has attempted to come up with some industry standards to guide designers of new trucks. Its "corrosion abatement position paper" states that "a user should not need to replace a component over the vehicle's useful life, or the useful life of that component, due to corrosion. This includes Ôsurface corrosion.' Additionally, the user shall not perform any maintenance (other than normal periodic washing) to prevent corrosion."

The paper then goes on to say that users would expect corrosion protection to last eight years on a heavy-duty truck or tractor, 16 years on a trailer or medium-duty truck body, and 10 years on a light- or medium-duty truck. It also says that corrosion protection for add-on components, such as liftgates, spare tire holders, reefers and toolboxes, should last as long as the vehicle to which they're attached.

About Killer Chemicals

Why are these new chemicals so much worse than salt? For starters, they're applied before any snow comes down, so vehicles are more likely to be exposed to the chemicals.

Secondly, both magnesium chloride and calcium chloride are "hygroscopic," which means they attract moisture from the air. They do this at very low humidity levels - 40% or even lower. If you get regular road salt on your vehicle, once it dries, it will generally not start corroding until it is wetted, say by more snow or light rain. Because these new chemicals will pull water out of even relatively dry air, they keep on doing their damage in all kinds of weather.

"If you don't get your truck thoroughly cleaned, even if you're driving in the summer in a hot humid town like Tampa, those chemicals will activate, so you truck will corrode all year round," says Greg Kinsey, engineering manager for Phillips Industries.

Adding to the problem is the molecule size of these salts - they're about half the size of standard salt.

"Those little molecules can fit into tighter cracks," Kinsey says. When the salts are liquefied, "they can cruise right under the heads of rivets, can go more places and get deeper into cracks than standard road salt. No one's invented a scrub brush that will go under the heads of rivets."

This property means that the corrosive material also works its way into any chips or cracks in the paint or coating, and can worm its way under the paint, causing corrosion you can't even see.

Some of the early research from the Winter Roads Program also seems to indicate there may be a compounding effect of these different chemicals. This is particularly relevant to long-haul truckers who travel through several states, collecting a mixture of regular road salt, magnesium chloride and calcium chloride on their vehicles. One of the problems, Alexander believes, is that the hygroscopic properties of the newer chemicals also help keep the regular road salt wet, carrying it into cracks and crevices it wouldn't reach on its own.

Even worse, these new chemicals have a higher surface tension, meaning they're harder to clean off.

"I've come across trucking companies that wash their trucks weekly and they still have problems," Alexander says, "So it's not simply washing it. It needs to be a pretty effective wash. Right now I'm not sure what the best way to do that is, but we hope to get more information as we go along."

Some truck makers have tweaked designs to try to make it easier to get at corrosion-prone parts for cleaning. At International, add-on parts like chassis skirts, for instance, are easier to remove so you can get in to clean the chassis.

Attacking Electrical Systems

One of the first areas where fleets started noticing serious corrosion problems was in the electrical system.

"We were starting to see more returns, and they were really nasty returns, stuff we'd never seen before, and failing a lot faster than ever before," says Travis Hopkey, director of marketing at Phillips Industries.

One of the weak points of a tractor-trailer is the seven-way connection. Because of the design of standard seven-way connector plugs, water can get in fairly easily.

Especially vulnerable is the tractor side of the connection, which is rarely unplugged and gets bombarded with spray from the drive tires. "Because the trailer is plugged and unplugged, opened and closed, seldom do you have problems on the trailer side," says Phillips' Kinsey. "People tend to plug the plug into the tractor side and leave it, and water can collect up in there."

Once moisture penetrates, the copper wire sucks it up like a dry sponge, several feet into the coil assembly. Even if you replace the head, the damage has already been done inside the coil. It adds to the resistance and decreases the voltage you're getting out the back. Some operators may not even know there's a problem until they get a citation for malfunctioning trailer lights.

Phillips' Quick Connect Plug, or QCP, addresses this problem. It features molded ends with replaceable cartridges. Not only are the molded ends, with their solid brass pins, more resistant to corrosion, they are also easily replaced when you do have corrosion.

"Inevitably, everything is going to corrode, anytime you have copper and electricity together," says Hopkey. "What you can do is try to push it off as long as possible." Instead of the typical 20 to 30 minutes it takes to replace the plug on a standard seven-way connector, Hopkey says, the QCP cartridge can be replaced in less than a minute.

No matter what type of seven-pin connector you spec, regular inspection and cleaning can help ward off corrosion problems. Wash the plug with water and a stainless steel brush, then regrease.

Seven-pin connectors aren't the only electrical components subject to corrosion. "Make sure electrical connectors are sealed against the environment," Alexander says. "Just because it looks like it's sealed, because it has a plastic connector, doesn't necessarily mean it's going to keep water out. Make sure you know whether they're designed to be water tight."

Phillips also has other products that it says resist corrosion better than standard industry versions, including its Sta-Dry sockets and QCS 2 harnesses.

Coatings Key

Coatings - paint, electrocoating, powder coating and more - can be significant in the prevention of corrosion.

Electrocoating, also called e-coat, uses a voltage potential or charge to deposit paint onto a part or assembled product as it is dipped into a paint bath. Then the parts are baked to cure the paint. It can be used as a primer coat, top coat, or both, and is used to coat car and truck bodies.

In powder coating, finely ground particles of pigment and resin are electrostatically charged and sprayed onto the products to be coated. The parts to be coated are electrically grounded, so that the charged particles adhere to them until melted and fused into a solid coating in a curing oven. OEMs are using powder-coating on many products. Makers of steel wheels have been using powder coating for several years, and International Marketing Inc. recently began offering powder coating as part of its wheel refinishing offerings.

One chemical that has traditionally been used in corrosion-resistant coatings is hexavalent chromium - the cancer-causing chemical compound made famous in the movie "Erin Brokovich." Because of the health risks to workers, the use of hexavalent chromium is heavily regulated. The European Union will soon prohibit its use on vehicles. This has led to the development of a variety of new types of coatings.

For instance, Elisha Technologies, a division of Orsheln, offers a process called Electrolytic Mineral Coat, or EMC. This process creates a silicate mineral surface on metals instead of chromates.

"From all the information I've gathered, these [newer] coatings are just as effective as the old hex-chromates," says Winter Roads' Alexander. However, he notes, new coating technologies tend to be a pretty exact science. They require special cleaning of the part before coating, the right concentration of chemicals, the right voltage or static charge, etc. "If the concentrations aren't high enough or the part isn't submerged quite long enough, the chemical isn't going to get to all the cracks and crevices of the part, and it won't be effectively coated. Make sure the coating manufacturer is following the proper procedures and protocols and they have good quality control in place."

Some in the industry contend that passenger car bodies are painted and sealed with better coating technology than those on many heavy-duty trucks.

International Truck & Engine says it uses the same process as the automotive industry - an e-coat, a base coat of paint, then a urethane clear coat.

"For the most part, we don't see [corrosion] issues with parts that are coated correctly and have not been damaged," says Ed Melching, director of International's Heavy Product Center. "If you have scratches or dings or anyplace the bare metal is exposed, you potentially are going to have some issues."

One of the key factors in the e-coat process, Melching notes, is that the cab is entirely submerged in the paint, and the electric charge encourages the paint to get into every nook and cranny. "You want to not only cover the outside of the cab shell, you also want to get into all the crevices, because if water gets in there, that's where it will corrode, from the inside out."

International also cuts all holes in the cab, even for special orders, before the coating process, not after.

With the launch of the High Performance Vehicle (International 4000, 7000 and 8000 Series), International began powder coating key chassis components, such as the fuel tank, battery box, air tanks, bumper, wheels and cab suspension. Powder coating offers much higher impact resistance, to avoid scratches that can act as entry points for corrosion.

Truck cabs are typically not where the worst corrosion problems lie. Many manufacturers of other components and add-on equipment are adopting more corrosion-resistant coating technology.

For instance, Waltco Truck Equipment Co. is using a powder-coat for its liftgate products that it says can add two years of life in the northern tier states. Liftgates are in one of the worst environments, on the rear of the truck, where they get not only the salt spray, but also stones thrown up that chip the finish.

"They're in the worst possible environment," says Dave Hammes, senior manager of sales and marketing.

Hammes explains that surface preparation is key to the powder coat process. The metal is prepared through shot blasting, then the components are powder coated in a system that electrically charges the paint and the surface to be painted so they flow together. The paint is electrically attracted to every nook and cranny. Then the sprayed material is baked at 400 degrees for an hour.

"Anyone who is not shot blasting is trying to get rid of rust and scale and impurities on the surface with chemicals, with a rag, and that doesn't work," he says.

The Holland Group also has products that are in a very exposed, harsh environment - fifth wheels, landing gear, trailer slider frames, and suspension components that are hit by stones, ice, dirt and, of course, salts. So in 2001, the company started looking for a new coating process.

"We found out there were two things that were causing our current and other competitive processes to corrode," explains Steve Dupay, director of research and development. "One, when you get those chips, the metal is exposed, and the rust starts there and spreads. The other one, which was sort of new to us, was the realization that most coatings allow water to pass through them, and that also causes corrosion."

After looking at a number of different coating technologies, Holland settled on one it felt would best address the shortcomings of its old paint system. The product, which Holland is calling Black Armour, reacts with the metal and mechanically bonds to that surface, then "grows" a protective skin on the steel.

"The result is an impermeable protective skin that's been 'grown' onto the steel," Dupay explains. "It's not adhered; it's mechanically bonded to the steel, so it won't peel off. It's integral to the surface of the steel, so corrosion can't run under the coating." It's also resistant to chips and scratches. Holland plans to have it on all its products by the end of next year.

"The main point I'd challenge the fleets with is, start asking questions of your suppliers - what can you do for me to improve corrosion resistance?" Dupay says. "Certainly manufacturers want to provide an excellent product, but the drive for improved corrosion protection being designed into the product, that request should be driven by the end customer to their suppliers."

As we've seen, there are a number of companies, associations and researchers looking into the issue of corrosion. The problem is, they need to talk to one another more.

"Probably the biggest issue we've come across is there's a lot of information out there, and not a lot of research that ties everything together," says Alexander. "Corrosion is a pretty complex process. It involves many factors which make it very difficult to just come up with a simple solution to prevent it."

The Testing Issue

While there's plenty of anecdotal evidence that these new anti-icing agents cause more corrosion than regular road salt, scientific evidence is harder to come by, and often contradictory.

That's because the standard test that has long been used to evaluate how well things stand up to road salt doesn't reflect today's real-world conditions.

The ASTM B117 test puts parts in a salt-spray cabinet where they are continuously wet. Yet in the real world, parts are exposed to wet-and-dry cycles. Other differences include the temperature changes that occur in the real world, and the fact that in the real world, vehicles are exposed to salts other than the basic sodium chloride used in the ASTM test.

Some coating and treatment processes performed well in the ASTM salt fog test, but were a disaster when put into the field -- and vice versa. Some materials have done poorly in the ASTM test yet performed well in the real world.

One test that many believe is superior is SAE J2334, "Cosmetic Corrosion Lab Test," which was developed by a consortium whose membership includes U.S. automakers and major steel producers. This test includes a humid stage at 100% humidity, a salt application stage, and a "dry stage" at 50% humidity. Researchers compared the lab test with real-world effects on trucks run for five years and found that 80 cycles of the SAE J2334 test corresponded to five years of on-vehicle testing.

A 2002 paper published by the Colorado Department of Transportation and the University of Colorado illustrated the problems with corrosion testing. The study sought to compare the corrosion effects of magnesium chloride and sodium chloride on automobile components.

When they used the SAE J2334 test, it showed that magnesium chloride was more corrosive than sodium chloride. But the results of the ASTM B117 test showed the opposite - that the magnesium chloride was less corrosive.

What You Can Do

Spec'ing

- Look for components with corrosion-resistant coatings.
- Opt for premium brake shoes when ordering trailers.
- Spec and retain brake dust shield.
- Consider stainless steel parts where affordable, such as fuel tank straps.
- Specify premium wiring systems, sealed wiring connectors.
- Specify full fenders - and fender liners when available
- Minimize specs combining dissimilar metals, which can cause corrosion when they touch, even without the help of damaging de-icers. Separate such components with insulation.

Maintenance

- Wash trucks frequently and thoroughly, especially the underside of the chassis and any points where dirt and water can collect.
- Hose out radiator/AC condenser regularly when de-icing chemicals are in use.
- Wax polished aluminum and stainless steel appearance accessories.
- Keep mudflaps in good repair to minimize salt spray
- Don't let today's long-life brakes keep you from inspecting brake shoes and linings. Remove brake drums so mechanics can see the entire lining surface and the brake shoe web, rollers, cam, etc.
- Specify rustproof painted or epoxy-coated brake shoes when rebuilding.
- Repair chassis paint stone chips as soon as possible.
- Don't drill unnecessary holes, and paint edges where you do drill.
- If parts must be repainted, have them repainted and recoated by a professional with corrosion-resistant products.
- Avoid splicing into wiring. If you must repair wiring harnesses or any kind of wiring, use shrink terminals.
- Do not probe through the insulation to test wiring, which simply opens an avenue for damaging chemicals to start corrosion.
- Clean out electrical connectors regularly with water (not soap) and a wire brush, and regrease with dialectric grease. Don't forget the seven-pin connector where it is plugged into the tractor.
- Protect battery posts and terminals with anti-corrosive spray

To help further research on the topic, fill out the survey at the www.winterroads.com website.

Wash Off That Salt

If you think you're immune to corrosion horrors, you're wrong.

JIM WINSOR
EXECUTIVE EDITOR

If you want to save your fleet a lot of maintenance headaches and expense, frequent and thorough washing is your best solution.

If you had attended the Technology and Maintenance Council fall meeting and saw the "horror show" of failed parts and severe rust and corrosion damage to trucks, tractors and trailers, your reaction might have been this could never happen in my fleet.

Wrong!

The worst evidence came from fleets that operate in the so-called Rust Belt, the states that are heavy users of salt and road chemicals put on roads to prevent or reduce ice and snow accumulation. But the story doesn't stop there. Some of the evidence also came from fleets based in Florida, Arizona and the South.

Some of the fleets dispatched rigs only occasionally to Rust Belt areas but these visits were enough to start the cancer of destruction. And like human cancers, if not caught early they spread rapidly, especially through wiring and connections. We saw tables-full of evidence fleets had brought with them… rusted-through spring brake chambers, failed fuel tank retaining straps, wheel nuts eaten away, trailer support leg crank handles, and even brackets and bushings eaten through.

There were a dozen brake shoes with severe rust jacking, the phenomena that takes place when corrosive road chemicals work their way between brake linings and shoe tables and rust away the surface, leaving the linings without proper support. In the worst examples linings had separated from the shoes; accumulated rust was 1/8-inch thick (For more on rust jacking, see our feature article, pg. 46, Sept. 2001 and my column pg. 78 of the same issue.)

Photographic evidence included severe body and frame rust, leaking engine oil pans, rusted-through rear axle housings also leaking oil, failed oil filter canisters, rotted rear trailer door frames, badly pitted chrome and aluminum front bumpers and even trailer reefer unit panels and doors that rusted through.

Speaker Darry Stuart from Quickway Transportation headquartered in Nashville and who has worked for fleets in New England, summarized the overall problem this way:

"Unless or until highway departments stop using the severe chemicals they're putting on their roads, those of us in the fleet maintenance business need to re-evaluate what we're doing and what we're buying.

"For starters, regular and thorough vehicle and undercarriage washing can make a big difference. The Hood Dairy fleet in New England has little rust and corrosion problems by getting the chemicals off before their attack sets in.

"Insure proper chassis and body preparation and coatings on new equipment. Require di-electric grease in all electrical sockets and connections. Discuss with suppliers the use of special paints and coatings.

"Consider stainless steel parts where affordable, fuel tank straps, for instance.

"Consider painting as a part of maintenance. This is something many of us have tried to stay away from but in some cases repainting is the most cost-effective solution."

Stuart's parting shot brought down the house: "Tell your drivers to drive a lot in rain storms!" His point was this is the cheapest way to wash the undercarriage and suck clean water through the radiator core, aftercooler and AC condenser. Road chemicals blasting onto these components can severely shorten their life.

Other speakers said it takes as little as two years for the killer chemicals to do their damage. And like cancers, it's much more difficult and expensive to deal with the issues once they've started.

Take this as a word to the wise.

KILLER CHEMICALS

What the states are using to de-ice roads is ruining your equipment & compromising safety.

Ordinary salt — sodium chloride — has been de-icing winter roads ever since it was pioneered in 1938 by New Hampshire's State Highway Maintenance Engineer LeRoy F. Johnson. It very quickly became the de-icer of choice across the nation and currently something like 15 million tons is spread over American highways each year, to the dismay of highway users who see the corrosive effects on the undersides of their vehicles.

Years of testing by car and truck manufacturers has seen the development of paints and other surface protections that keep the worst ravages at bay.

Now, though, there are new de-icing chemicals increasingly going down on the nation's roadways that are posing a different corrosion threat. And the parts that are corroding are electrical wiring, truck frames and suspension parts.

And, most alarmingly, brakes.

MAGNESIUM CHLORIDE: A MIRACLE CORRODES

Back in the early 1990s, the people who maintain roads in cold climates thought they had found a miracle. It came in the form of a chemical compound, a liquid solution of magnesium and chloride, that lowers the freezing point of water. When sprayed onto roads before a storm, mag chloride prevents snow from sticking and ice from forming.

Everywhere they looked, state road departments saw benefits from mag chloride. By keeping roads clear they prevented accidents and kept traffic moving. They didn't have to use as much sand, so they had less pollution. Less salt meant fewer complaints about corrosion, and less environmental damage to farmers' fields. The chemical was more expensive than their traditional tools, but when they were done with the math it was no contest: mag chloride delivered more than it cost.

Snowfighters are committed to public safety yet face the public's wrath when snow and ice gain the upper hand. In mag chloride, they were thinking, they had found a way to conquer demon winter.

But real miracles are few and far between, and it is clear that mag chloride is failing to make the grade. The compound is turning out to have long-term effects that tarnish — literally — its early reputation as the salvation of winter travel.

Truckers, who face the greatest exposure, are saying that mag chloride packs a killer punch. They have found that its corrosive properties are eating away at vital components.

Often the damage is cosmetic —the chemical eats into aluminum and stainless steel, pitting and scarring the surfaces that give well-maintained equipment a pleasing appearance.

But some damage runs deeper. Fleets that have been exposed to mag chloride report that their wiring systems are deteriorating at an alarming rate. Maintenance people believe the chemical wicks into connection points and eats away at copper wiring.

And truckers in some types of operations are expressing even more serious concerns. They are seeing damage that scares them: corrosion in structural elements that could lead to catastrophic failure at highway speed. One maintenance vice president at a national LTL fleet described pushing his pen clean through a structural element on a trailer suspension that he believes had been rotted by mag chloride.

In fact, truck maintenance professionals are alarmed. The Technology and Maintenance Council of American Trucking Associations has scheduled a study session on corrosion problems in brakes, and ATA has asked the Federal Highway Administration to support an in-depth study of de-icers, including mag chloride.

With these bells going off, you would think that trucking companies, equipment suppliers and the highway maintenance community would be arm-in-arm in search of a solution. But that's not happening, at least not in an effective way. Lack of information, poor communications, political interests and plain-old hard-set attitudes

are hampering progress.

What's most worrisome to trucking interests who are following the issue closely is the potential long-term threat. For one thing, states are using more mag chloride, which increases exposure. For another, corrosion problems are being spread through the national fleet by equipment turnover.

Generally, fleets say it takes time for mag chloride damage to show up. So fleets that wash their equipment regularly, and turn it over on a two- to three-year cycle, might avoid much of the problem. But maintenance professionals say that once mag chloride wicks into a joint between two metals, it's there to stay unless you disassemble the pieces, clean them and paint them. In effect, equipment turnover shifts the corrosion problem to the second or third owner, who may or may not be prepared for the hassle and expense of proper maintenance.

This could lead to safety and repair issues that expand far beyond the states where mag chloride is used.

"We're only at the beginning of the problem," says Greg Fulton, president of the Colorado Motor Carriers Assn.

Fulton is involved because Colorado is a leading user of mag chloride, and his members are reporting serious problems.

Dino Guadagni, vice president of Western Distributing, a nationwide truckload carrier of dry and refrigerated freight based in Denver, says that at first mag chloride just caused cosmetic problems. It corroded the aluminum on tractors, dry vans and reefer trailers.

But now he's experiencing "astronomical failures" in his wiring systems, he said.

Mag chloride corrodes his wiring several feet at a time — on equipment that is only four months old, he said. "I've never seen anything like it."

The trouble is, the Colorado Department of Transportation has never seen anything like it, either — so it is not convinced that there's a problem.

Tom Norton, executive director of the Colorado Department of Transportation, said he has heard concerns about wiring problems related to mag chloride. But he has seen no specifics.

"There is no scientific evidence to prove it," he said. "We are having trouble confirming that from a laboratory perspective."

Asked about a study under way at CDOT on mag chloride corrosion, Norton said, "We have learned nothing that confirms or denies concerns about corrosion."

These conflicting perceptions exacerbate the problem. Truckers are nothing if not practical, and to them the cause of the damage is self-evident. With regular washing and proper maintenance you eliminate all the other explanations, and what's left is mag chloride. Yet as far as Colorado is concerned, it has to be proven in the lab before it can be officially recognized.

This disconnect has contributed to tension in Colorado. Truck lines and the DOT say they want to work together, but each expresses frustration with the other.

Bureaucrats love magnesium chloride, because it solves their problems, said a trucking vice president who asked that his name not be used. The way Colorado truckers see it, CDOT's insistence on scientific proof of wiring corrosion is just a way to shift the problem away from itself.

Says Norton of CDOT, "We have tried to work with the industry. We have had many ups and downs. But the industry has been very much less cooperative than we would wish."

Norton adds: "We want to work with truckers in an equal way. We will continue in spite of negative attitudes."

On behalf of Colorado carriers, Greg Fulton says, "We recognize that there are clear values and benefits related to mag chloride. But there are inadvertent consequences related to corrosion. We need to work together toward a solution. We don't want to get rid of mag chloride, we just want to fix its problems."

Meanwhile, what are trucking companies supposed to do to protect their equipment?

For answers, *HDT* turned to the segment of the industry that has the greatest exposure: the fleets that put the product to the road.

While Colorado awaits laboratory results, maintenance personnel for state fleets in Idaho and Montana do not hesitate: the problem is mag chloride.

"I think the number one corrosion problem with de-icer is that it attacks the wiring the worst," said Montana state fleet manager Jack May.

"If you have a wire that you have probed, it will eat through the conductor in a week," he said. "De-icer will seep into junction boxes and electrical components with wiring connections and circuit boards and destroy them in short order."

His recommendation: "A rigorous program of faithfully washing the vehicles." He also suggests improving wiring harnesses, sealing junction boxes and painting exposed surfaces.

Of course, a rigorous washing program is one thing for a route operation in which the trucks return home each day, but quite another for an interstate truckload carrier that is passing through a mag chloride zone. Dino Guadagni of Western Distributing expressed frustration at the suggestion: there aren't too many truck washes on the roads he uses west out of Colorado, and in any case it takes special washing to actually get the mag chloride off the truck, he said.

One tank trailer manufacturer reports it has solved the problem. William Boyd, vice president of engineering and purchasing for Heil Trailer International, Chattanooga, Tenn., said his company has worked with its paint supplier to come up with a combination of coatings that resist mag chloride corrosion.

The process begins with surface treatments, is followed by undercoats, including a "shock absorbing" layer to protect against flying stones, and is finished with a surface coat. In addition, wiring harnesses and junction boxes are completely sealed, and the junction boxes are packed with grease.

This protects the tanker but costs the customer $2,000 per trailer for the paint alone, Boyd said. That's an incremental cost that may not stand up as well in the dry freight market where trailers are more of a commodity than a capital investment.

One of the reasons trucking concerns have only slowly been recognized is that automobile owners are not reporting similar problems. That is partly because cars have less exposure than trucks, but Boyd also faults truck equipment manufacturers.

"Auto manufacturers have invested in protective materials," he said. "Shame on us."

One fleet executive who did not want to be identified said that fleets also need to get involved by specifying their equipment more carefully. They should demand metals that are more resistant to corrosion, he said.

Practically everyone agrees that in the long run the answer will be found in better formulations of mag chloride — in particular, through the addition of the right kind and quantity of corrosion inhibitors. This won't be easy, since mag chloride's performance depends on how it is applied and the climatic conditions.

As trucking interests try to raise the profile of the issue, it may help that others are pointing to new problems.

In Colorado, power companies are complaining that mag chloride mist stirred up from the road by passing vehicles is settling on the insulators on their power poles — causing them to conduct electricity rather than block it. The result has been power outages and spontaneous combustion of power poles, according to news accounts.

Also, Colorado residents are charging that mag chloride — previously thought to be harmless to vegetation — is killing spruce and fir trees.

These and other complaints may help accelerate the process of completing the scientific examination of mag chloride — but the politics and chemistry of the issue still make for an uphill climb.

As Dan Williams of the Montana Department of Transportation put it, "We are concerned and will continue to look for chemicals that reduce negative impacts.

"To date, there are no silver bullets."

SAFETY THREATENED BY BRAKE CORROSION

Of immediate safety concern is widespread evidence that the significant increase in the use of de-icing chemicals on highways is impacting the life and performance of S-cam brake shoes and linings. Severe rust build-up on the brake shoe table, called "rust jacking" by brake engineers, is causing brake linings to deform, work loose, crack and break.

The photo on page 104 is graphic evidence of what can happen.

Not surprisingly, the worst cases we've seen come from tractors and trailers domiciled in western New York state right in the heart of the aptly named "rust belt." These Eastern and Midwestern states are heavy users of rock salt. In addition, some states

have added or changed over to calcium chloride and magnesium chloride compounds, which have an affinity for attracting moisture and consequently do a better job of melting ice.

The problem is not restricted to rust-belt domiciled carriers. Darry Stuart is an independent consultant working with eight different fleets. He has seen fleets domiciled in Nashville, but running nationally, with bad rust jacking. Stuart says some shoes look like they expanded as rusting set in and then rust flaked off in pieces the size of corn flakes. Lower-priced aftermarket shoes/linings appeared the worst, he said.

Stuart also works with a large New England-based fleet with rigs running constantly in salt spray during the winter months. That company — because of its awareness of the corrosion issue — is not having rusting problems. Stuart says its preventive maintenance checks are on shorter intervals and are very thorough. Consequently, brake lining life is excellent.

That, however, wasn't always the case. Stuart is a major practitioner of "management by wandering around," spending at least an hour or more on shop floors, digging through dumpsters and analyzing scrap piles. "They all tell a story," he says, "and it was a brake shoe scrap pile with over 100 shoes in it that really got my attention. Mechanics were pulling off brake linings which weren't 50% worn but were cracked, loose around the rivets and showed very uneven lining wear. No one in management was paying any attention to what was obviously a problem. Mechanics just slapped on new shoes to get the vehicles back out on the road."

Why is "rust jacking" showing up now? Road chemicals are acknowledged to be the culprit. Chemical-laden road spray gets onto brake shoes and, depending on the quality and type of coating on the shoe itself, goes to work. Corrosive moisture works its way between the shoe and lining and eats away at the shoe table, gradually undermining the lining until it becomes loose, cracks or fails.

Larry Strawhorn, vp of engineering of the American Trucking Assns., says he remembers "rust jacking" as an issue back in the '60s when he was an engineer for a major truck manufacturer. "But things have changed significantly for the better since then," he says. "For one thing, once we realized what was happening, the industry adopted new ASTM test procedures and parts were exposed to salt sprays for hundreds of hours. Brake manufacturers developed better paints and coatings and for the most part, we haven't heard much about rust jacking until recently."

Strawhorn points out there can be significant brake safety issues because with uneven, loose, cracked or broken linings, brake performance can deteriorate gradually and often not be noticed by a driver. "This is one reason that DOT and CVSA have stringent inspection standards for brakes including the linings. Any crack more than 1/16-inches wide and 1-1/2-inches long is cause for inspectors to place a vehicle out of service." This means the vehicle can not be driven until repairs are made.

The message here is that fleets must pay more attention to brake linings whether they are in the "Rust Belt" or not. Bob Rosenthal, national service manager for ArvinMeritor, one of the principal OE brake suppliers, points out that many improvements and technical changes have been made in S-cam brakes in the last 20 years, so brakes in most applications are not the high-maintenance items they once were.

Prakash Jain, ArvinMeritor's director of technical support, adds that his company — as well as others — developed long-life or extended life S-cam brakes which among other features have thicker brake linings. The lining industry changed to longer-lasting non-asbestos. These changes alone mean that in many over-the-road fleets, 500,000 miles or more between relines are not unusual, especially when engine brakes are used.

As Darry Stuart points out, five years between brake relines isn't unusual on tractors anymore. "And if you have trailers that sit around at customer's facilities, these don't get the miles and I've seen seven years on the same linings." Translation: It used to be that worn-out linings meant more frequent brake jobs. Now it doesn't. Years can go by without thorough brake shoe and lining inspections . . . thorough meaning the removal of

brake drums so mechanics can see the entire lining surface and the brake shoe web, rollers, cam, etc.

Jim Clark, Dana Corporation's chief brake engineer, points out several other key issues that fleets need to consider, especially in the selection of replacement brake shoes and linings. Aftermarket parts do not have to meet the same DOT FMVSS-121 performance standards as new. So there are varying quality levels, driven by competitive pricing.

Clark says brake shoe paints and/or coatings have changed a lot over the years and this has impacted resistance to "rust jacking." He says some manufacturers and jobbers paint or dip shoes; that with the change in EPA regulations pertaining to paint VOCs, water-based paints have become more popular as have dips. When asked what's most durable, Clark said, ". . . Epoxy coatings are the best. You'll find that the premier brake products we sell to our OE customers are e-coated." This is not to say, however, that all new S-cam foundation brake shoes are e-coated. Fleets should check on both new and replacement shoes.

Does this mean that all e-coated shoes are impervious to "rust jacking?"

Not necessarily. Clark, who is very active on SAE brake committees, said the time has probably come to re-evaluate test procedures. "With the increased use of road chemicals, especially the use of the new chlorides, maybe we (the brake industry) need to take a new look at the ASTM test procedures we've been using. Do we now need new and longer durability spray tests using some of the newer road chemicals?"

In the meantime, Clark shares the same recommendations all the experts we interviewed have: Inspect brakes thoroughly on a schedule. Pull brake drums on a regular basis, especially on vehicles five years and older. When replacing shoes and linings, thoroughly examine the ones coming off, don't just scrap them.

Know what you're buying for replacements including shoe treatment. Some OE shoes have labels on the shoe web which identify the linings on the shoes. Often this label is removed or painted over by local shoe reliners.

Don't ignore automatic slack adjusters. If "rust jacking" is a problem, make sure ASAs are thoroughly lubed and that there's no evidence of internal rust/corrosion.

In conclusion, "rust jacking" produces short lining life, sometimes 50% less than is expected. "Rust jacking" leads to brake safety issues. The problems are driven by premature shoe deterioration that damages linings. Both safety and economic issues are involved. Don't ignore them.

CORROSIVE CHEMICALS

What's really in what they're putting down on the roads.

There are several dozen new de-icing formulations available, but by far the most widely used are calcium chloride and magnesium chloride. In a survey a year ago, *Better Roads* magazine found that 58% of respondents used the old standby, salt, but 22% use calcium chloride. Another 8% use the newer magnesium chloride. In all, 88% of these respondents used chlorides to de-ice roads and the chloride ion is what causes corrosion.

Maintenance Manager's excellent three-part corrosion analysis, published by the Technology and Maintenance Council of ATA.

Magnesium chloride — which many think is responsible for the added corrosion starting to appear on vehicles and on the highway infrastructure (bridge rebar, roadside electrical fixtures) — may not be used by many of the *Better Roads* survey correspondents, but those that do, use it a lot. According to the TMC corrosion series, Colorado reportedly used six million tons of it in the winter of 1999/2000.

Calcium chloride is arguably even worse. Because it attracts and absorbs water from the air, it will creep into crevices and wick up wires. According to Baboian, this deliquescent characteristic is why calcium chloride is also spread on dirt roads: its propensity for sucking up water wets down the dust. That's a very good argument for staying off dirt roads in the summer months, he says.

Proponents of both calcium and magnesium chlorides say they are less corrosive than conventional salt. They are more expensive than plain salt, which is one of the most plentiful compounds found on earth, but they have additional properties that make them better at melting ice. When the final accounting is done, they are less expensive, particularly in areas where the strategy for de-icing is the so-called anti-icing procedure, where the chemicals are spread on the bare highway prior to an anticipated winter storm.

There are non-corrosive alternatives to chlorides for winter de-icing. An alternative that has the support of most corrosion authorities is calcium magnesium acetate, or CMA. According to a technology brief for the Federal Highway Administration prepared by the Turner-Fairbank Highway Research Center, CMA and its partner potassium acetate or KAc " . . . are de-icing chemicals most benign to the environment." The report notes that not only do the chlorides corrode vehicles and bridge structures, but that ground water contamination by chlorides can be harmful to people.

That does not go as far as a Canadian report authored by Professor Harold D. Forster of the University of Victoria. It suggests that de-icing chlorides may be carcinogenic. This report is hotly denied by the Salt Institute, whose members supply the millions of tons of salt used to de-ice United States' and Canadian roads.

Interestingly, Idaho — which uses magnesium chloride as its preferred de-icer and anti-icer of winter roads — has a detailed justification of its use on the Transportation Department web page, presumably to forestall criticism of the chemical.

Groundwater is not only compromised by the chlorides, but also by the additives used in an attempt to make the chlorides less corrosive and to prevent caking during spreading. Principle among them is sodium ferrocyanide, which releases cyanide ions — highly toxic to fish and not overly benign towards people.

Other organic compounds that are being tried as alternatives to chlorides include methanol. In a 1980 report for FHWA, Dunn and Schenk noted that the alcohol was very good at clearing ice, but that it was "less persistent" than salt. However, CMA acts at about the same rate as salt, and is as persistent. The report also notes: "In strong contrast to NaCl (salt), CMA is a corrosion inhibitor, is beneficial to most soils and has no potential for harming drinking supplies."

Wheels in Winter Preventing Corrosion

Steel wheel corrosion can dramatically affect the performance of the wheel.

Evan Lockridge
Contributing Editor

Today's winter roadways are often a corrosive and abrasive soup of moisture, road salt, sand and de-icing chemicals - and your wheels live right in the middle of it.

Aluminum wheels have become more popular in recent years for their light weight and greater resistance to corrosion, but they're not necessarily the right answer for every operation. They cost more than steel wheels, and fleets that have to drop their trailers in less-than-desirable areas have concerns about aluminum wheels being stolen. So there are plenty of fleets still operating steel wheels and fighting the corrosion battle.

"We have switched to - and we're using - as much aluminum as we can, but we still have a lot of steel wheels out there," says Chuck Diehl, fleet manager for Smith's Dairy in Orrville, Ohio, a private fleet with about 400 pieces of equipment that keeps its trucks for a decade or longer.

"If we can get a year, year and a half out of that (steel) wheel where it still has a good-looking appearance, we're saying that's pretty good right now." Diehl is frustrated with his experience with having the wheels refinished. "We just can't get any life out of a reconditioned steel wheel," he says.

Diehl's experience was echoed in a presentation on refinishing steel wheels during the first gathering of the new Corrosion Control Action Committee at the fall meeting of the American Trucking Associations' Technology and Maintenance Council.

Dale Overton, field engineer for the wheel manufacturer Accuride, is a member of TMC's tire and wheel study group and the corrosion committee. He explained that fleets running steel wheels in the snow belt are having the exact problems Diehl described - they might get three years of life out of the OEM wheel, but after that, find they're refinishing yearly to keep corrosion from adversely affecting the wheels. He said today's truck technicians must continually monitor the corrosion effect on wheel life, especially when it comes to steel wheels.

Allow corrosion to build up, Overton said, and it could affect the operation of the wheel. "If you have corrosion buildup, it can dramatically affect the performance of the torque retention on the wheel and wheel end."

Diehl notes that even corrosion that affects only appearance, rather than performance, is still a problem. "No.1, you don't want your fleet to look that way; No. 2, that's an attention-getter for roadside inspectors."

Overton said to get the most life from a steel wheel, it is important to spec it with corrosion resistance in mind. For example, there are big differences in wheel coatings. Overton demonstrated this by showing a slide of a wheel with a typical e-coat primer and one with a powder top coat, both with four years of service. The powder-coated wheel clearly showed less corrosion.

The real problem with steel wheels shows up when it's time to refinish. To get the most life out of your reconditioned wheels, it's vital to closely monitor the quality of steel wheel refinishing, especially maintaining control of paint thickness and the cure of the refinishing.

In its Recommended Practice on wheel and rim maintenance, TMC offers the following steps that should be taken during the reconditioning process:

1. Initial in-house inspection. Any wheels with cracks, dents, leaks, severe wear, or rust pitting should be scrapped.

2. Tracking. Make sure you get your own wheels back.

3. Cleaning. The objective is to remove loose paint, dirt and debris without cutting into the metal. If the surface is not prepared correctly, the new finish will not adhere, creating bubbles or cracks where corrosive liquids can get in and eat away at the steel below the paint.

4. Inspection. Often fatigue cracks or rust pitting are clearly visible only after the wheel is cleaned.

5. Painting. The total thickness of the dried paint coating on each side of the wheel mounting face must not exceed 3 mils. Excessive paint can lead to loose fasteners, premature wear or wheel loss. If the paint's too thin, on the other hand, it doesn't provide the proper corrosion protection. If the paint is not cured properly, it can have the same effect as excessive paint thickness.

Make sure your wheel reconditioning contractor is following these steps. Not all aftermarket refinishers are created equal, Overton noted. You also may want to look at companies that offer different corrosion-resistant coatings. For instance, he said he knows of one that has an e-coat system to apply primer. Another uses a powder primer that can be partially cured and a second coat is applied to the top of that to be finally cured. Some use an etching primer with a powder topcoat for superior performance.

Meanwhile, wheel makers continue to research ways to improve their products. In the future, Overton said, there may be even better alternatives than anti-corrosion coatings or aluminum wheels. "Down the road, we're going to look at implementing some space age technologies."