

September 2011

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By Brian Hirt
Contributing Author

Liquid-only diet

Agencies tackle selected storms without salt

Every winter storm is the same.

Except for the amount of snow and ice. And snow moisture content. And air temperature. Pavement temperature. Wind. Humidity. Time of day. Traffic levels. Available winter maintenance staff. Available removal equipment.

Those and a dozen other variables form the No. 1 axiom of winter maintenance: Every winter storm is (of course) different. And that is the reason the search never ends for new tools to help make roads safe for motorists in the most efficient and environmentally friendly way, regardless of the storm that blows in.

The predisposition toward innovative thinking in the winter-maintenance world led to a novel method of using deicing and anti-icing liquids: applying them during winter storms, in place of solid chemicals. The process is called during-storm direct liquid application, or DLA, and a scattering of agencies across the U.S. have already demonstrated its promise.

DLA offers significant advantages over solid chemicals: reductions in material use, lower environmental impact, enhanced effectiveness and cost savings. As with any new technique, though, the question becomes: Does it really work? When does it work? And how does an operator go about implementing this



technique, making it an accessible tool in the winter maintenance toolbox?

A funny thing happened on the way up the mountain

The application of liquid salt brines and solutions of other chlorides to roadways in advance of snow events is already a commonplace and accepted practice. So too is the use of liquids to pre-wet granular salt or to create liquid-solid slurries for plow routes. During-storm DLA is a much newer technique, but stories already abound about the possibilities.

One pioneering example comes from Utah. The 12 miles of I-80 east of Salt Lake City are a daunting climb of 3,200 ft to Parley's Summit. A few years ago, Roger Frantz, Parley's Canyon maintenance station supervisor for the Utah DOT, discovered that it was possible to



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keep the roads snow-free by combining plowing with the timely application of liquids both before and during winter storms. Crystalline salt has not hit the pavement in years.

Lynn Bernhard, Utah DOT's maintenance methods engineer, said, "The results were remarkable. We conducted a level-of-service study on the road, and on our scale of A+ to F-, it earned an A. Most other routes in the district get a B or B+." Bernhard continued, "Keep in mind, this is a mountain pass that gets 350 in. of snow a year at its summit and 80 in. at its base. Compared with routes that use solid salt, this one required a lot less labor and half as much material."

So is DLA poised to render granular salt obsolete for winter maintenance? Bernhard would be the first to say it is not as simple as that, since every storm brings a different challenge. But as word of this promising new approach spread among winter-maintenance engineers, it was clear that the time had come to see what kind of practical guidance could be developed from the individual experiences of Utah and other states.

Clear guidance from Clear Roads

Clear Roads (www.clearroads.org), a consortium of 21 state DOTs that has investigated a variety of winter-maintenance materials, equipment and methods since 2005, rose to the task. In 2010 the group initiated a

research project to take a closer look at during-storm DLA (sometimes called liquid-only plow routes). The goal was to learn from practitioners and experts and develop practical reference materials for implementing this technique.

EVS Inc., a Minnesota-based company with expertise in transportation and environmental research, conducted the study with guidance and oversight from Clear Roads. Investigators surveyed and interviewed road agencies with experience using DLA and gathered information from international practitioners, weather forecasting experts and airport snow- and ice-control professionals. Based on this input, investigators identified the most effective circumstances and methods for using DLA during winter storms.

In addition to a final report, Clear Roads published a quick-reference guide that outlines the key considerations for DLA use. As the guide spells out, effective use of DLA comes down to three main factors:

- Pavement temperature: Temperatures of 25° F or above are most favorable for DLA. As pavement temperature drops below 20° F, DLA becomes less appropriate;
- Storm intensity: Storms up to 1 in. per hour are generally good candidates for DLA. The technique is most effective for storms of half an inch of snow per hour or less; and

- **Moisture content:** Storms with ordinary moisture content (approximately a 10:1 ratio of snow to liquid) are most favorable for DLA. Storms with drier snowfall also were identified as candidates for DLA; wetter snows tend to dilute the deicing liquid quickly, which can lead to refreezing and icy conditions.

These factors all suggest why DLA works so well on the climb up I-80 in Utah. Bernhard explained, "The action

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of air lifting over the mountain leads to consistently warm, dry snows, which makes it possible for us to stay ahead of them with DLA."

That is just part of how Utah made DLA work even in heavier snowfalls than are generally considered desirable for DLA. "We took a number of steps to make this strategy work," Bernhard said. "Monitoring the ground temperature closely and using advanced weather forecasting is absolutely critical. Also, we use 5% calcium chloride in our brine when necessary, which further depresses the freezing point from 15°F all the way down to -10°F."

He concluded, "DLA has proven to be a very effective tool for this route, and we've targeted new routes in Salt Lake City and Ogden for the coming winter. We will still use granular salt as backup in those areas, since we don't expect liquid-only to be the best choice all of the time."

Greener, faster winter maintenance

Allen Williams, Salem District maintenance engineer for the Virginia DOT, sees the potential benefits of DLA in Virginia. "We haven't yet tried liquid-only routes, but in the eastern part of our state where it's warmer and more conducive to this type of application, as the Clear Roads guide suggests, we are interested in getting something started,"

he said. This summer, discussions are progressing among maintenance managers in Virginia's Tidewater area about a possible pilot test there.

"What makes this particularly exciting for us are the opportunities to limit the amount of chlorides that we're using in Virginia," Williams said. "This research is helping us identify the proper place, environment and operating conditions to use DLA."

Williams explained that in conditions where liquids work, they are far superior

to solid chemicals. "The melting rate is faster with DLA, since it's already a liquid when it's applied," he said. "We have to pre-wet granular salt to make it work or wait for it to get wet."

This effectiveness makes DLA even greener and more cost-effective. "There's an interesting human factor in all this," Williams said. "With traditional granular salt routes, sometimes people are simply too anxious to see the roads turn back to black during a winter storm. As a result, we compensate by reapplying chemicals more quickly than we need to. Faster-acting liquids, on the other hand, mean faster results, and in turn, fewer applications. That saves money on materials. More importantly, it means we use less chlorides on the road."

Just as Utah's Bernhard noted, Williams said that attention needs to be paid to weather and pavement temperatures. "Liquid can dilute quickly," he said. "If you apply a brine at 32°F and the temperature drops to 20 after the liquid dilutes, you can have an ice rink on your hands. Looking at forecasts is part of the 'right time, right conditions' equation."

Indiana, like Utah and a handful of other states, has already implemented DLA routes on a limited basis, and engineers there have plans for more.

"We have had three liquid-only routes for the past two winter seasons, and this year we have a goal of adding a fourth," said Tom Kasten, Winamac

Subdistrict operations manager for the Indiana DOT. "There is no doubt in my mind that this is a huge saving tool. For example, for the 2010-2011 winter season we used during-storm DLA on the passing lanes of a four-lane highway, and it made an unbelievable difference."

Kasten explained that passing lanes experience significantly less traffic, and the friction from the tires on the pavement is needed to help granular salt start working. "Moreover, with granular salt, at best you'll get 70% of the material to stay on the road," he said. "With liquid-only application, 100% of the salt goes onto the road and goes straight to work. We really had excellent luck with DLA in this circumstance."

Kasten cautioned that DLA is not the right tool for every occasion.

"Sometimes it doesn't work," he said, "but we've found that often when liquid isn't working, typically granular salt isn't working either."

Kasten pointed to the value of the Clear Roads guide as a good starting point. "The guide probably errs on the conservative side," he said. "We go into lower pavement temperatures than the report indicates, down to 0°F, but that was with a heavier application rate. We might not have attempted that the first year, but we've become more confident with each passing year."

New technique in New England

Even though the guide suggests milder climates and lighter snows as the most ideal for DLA, the technique is being considered in snowy Maine. Maine DOT Highway Maintenance Engineer Brian Burne explained, "As another tool in the toolbox, there are times when DLA can be the right fit here, such as at the start and end of the winter season."

Burne said that Maine does not have any experience with DLA yet, but with the Clear Roads findings now in hand, discussions are under way about trying it during an upcoming winter season. "We feel that this research will give us a better chance of success," Burne said. "Knowing how this strategy has been used successfully in other

Using the Clear Roads guide to DLA

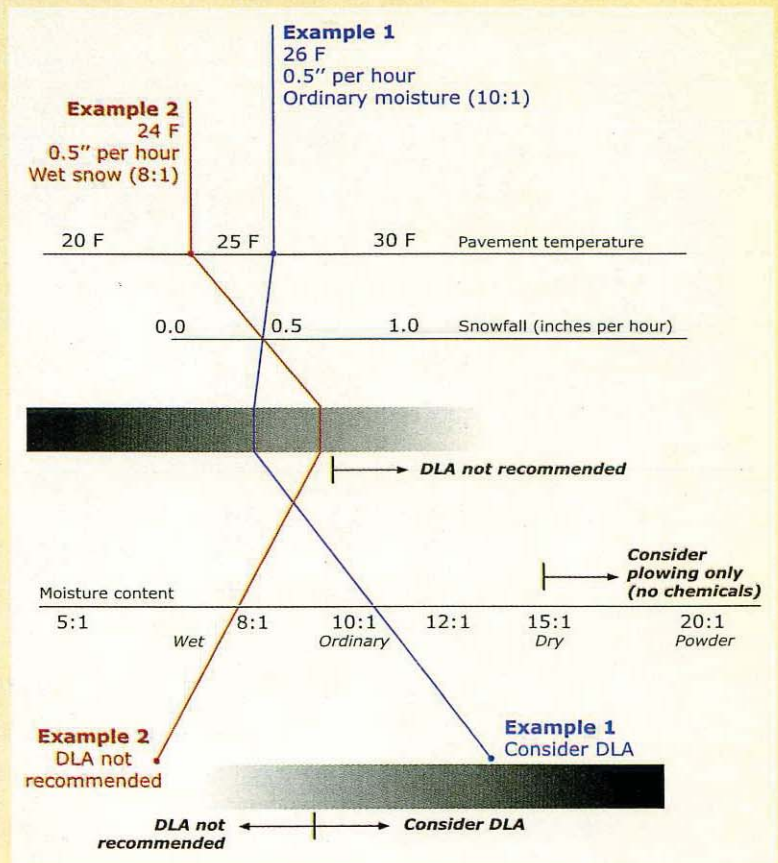
Clear Roads' DLA Quick Reference Guide is available online along with the final research report at <http://clearroads.org/research-projects/downloads/Quick-Reference-Guide-revised.pdf>. Three simple inputs—pavement temperature, snowfall intensity and moisture content—are used to generate initial guidance on whether during-storm DLA is an appropriate tool. The chart on the right, from page 4 of the guide, shows two examples.

In both examples the snowfall rate is 1/2 in. per hour. Example 1 represents a snow of ordinary moisture content and a moderately cold pavement. Example 2 shows a wetter snow and somewhat colder pavement. The guidance chart suggests that during-storm DLA may be appropriate for 1, but perhaps not for 2.

Like all the tools in the Clear Roads guide to DLA, this chart provides suggestions to help an agency initiate during-storm DLA in the field and learn what works best for its individual needs. These are not hard-and-fast rules—recall how Utah makes DLA work for heavier snows in the right circumstances.

The guide also includes representative application rates for DLA routes. The table below from page 2 of the guide represents a good starting point from which an agency can adjust accordingly based on the unique characteristics of a given route or storm.

During-storm DLA guidance chart



Example during-storm DLA application rates for sodium chloride brine gallons per lane mile (pounds per lane mile)

	Pavement Temperature (°F)			
	32-30	29-27	26-24	23-21
For application cycles of 2 hours or less				
Light Snow (less than 0.5" per hour)	20 (45)	35 (80)	40 (91)	55 (125)
Medium Snow (0.5" to 1.0" per hour)	35 (80)	45 (102)	55 (125)	not recommended
For application cycles of 3 hours				
Light Snow (less than 0.5" per hour)	35 (50)	50 (114)	65 (148)	80 (182)
Medium Snow (0.5" to 1.0" per hour)	50 (114)	65 (148)	80 (182)	not recommended

states should shorten our own learning curve considerably."

Burne noted that one advantage of DLA is that it does not require the purchase of new, specialized equipment. "If you're already equipped to make and store brine, and if you have vehicles that can apply pre-storm liquids, then you have the tools to begin," he said. "For us, the crews in our state furthest along with salt brines are the ones who will be

most likely to try DLA, since a big part of succeeding at this is getting used to new techniques. Those most familiar with pre-storm anti-icing are most likely to try during-storm DLA next. It's pushing the technology one step further."

Burne concluded, "The Clear Roads guide to DLA is an important document in the snow- and ice-maintenance world. Given the endless variety of winter storms, expanding the variety of tools

to take them on can only lead to more effective winter maintenance." **WM**

The Clear Roads pooled-fund project (TPF-5(218)) focuses on rigorous testing of winter maintenance materials, equipment and methods for use by highway maintenance crews. This ongoing project is led by the Minnesota Department of Transportation, with 21 member states across the country.

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