Advantage
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Hauling wood chips in winter

Abstract

When hauling wood chips in winter, frozen loads can create costs that are rarely included in the haul rates; these include downtime, lost payload capacity, and hours of manual labor to remove the chips. Contractors have tried many methods to solve the problem, and most have arrived at acceptable solutions. FERIC has spent the past two winters working with contractors in northwestern Ontario to identify their "best practices" and test additional solutions. This report summarizes these best practices and new preventative practices identified during FERIC's study.

Keywords:

Chip trailers, Chip vans, Wood chips, Winter operations, Frozen wood chips, Parasitic weight, Prevention, Downtime

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Introduction

Frozen loads are most common when warm, moist wood chips or sawdust are exposed to cold weather. This can result from fluctuating temperatures in late fall and early winter or late winter and early spring, when temperatures often range between 5°C and –5°C. It can also result from loading warm, wet chips from the center of a stockpile or fresh from the chipper into a cold trailer. Any snow, ice, or water on the trailer floor compounds the freezing problem. Under these conditions, the question is not whether freezing problems will arise during unloading but rather how serious the problems will be (Figure 1). The answer depends on how long the wood chips remain in the trailer and on the severity of the conditions; the freezing problem could be as little as a few shovels full of chips, or as severe as a few tonnes.

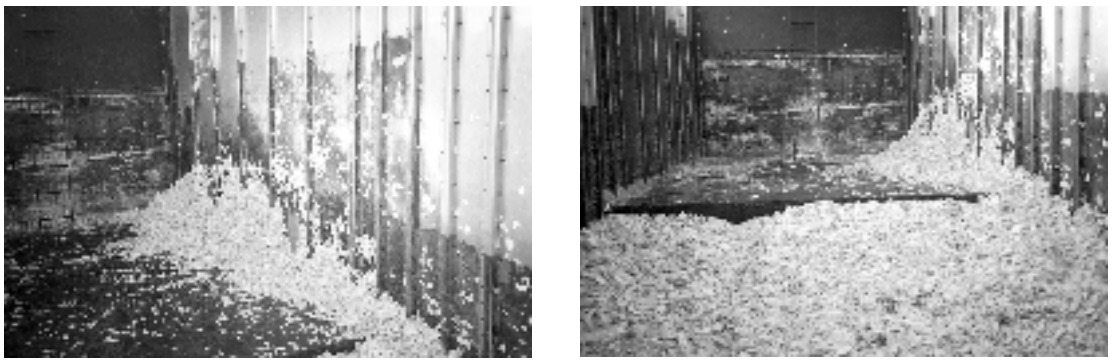

Figure 1. Minor (*left*) and serious (*right*) freezing problems.

To improve efficiency in chip haul operations, trailer designs are targeting the maximum possible payload and improved aerodynamics. Simple modifications have included moving structural ribs inside the trailer's walls (to reduce drag) and adding drop bellies to increase the van's volume (thus, its payload). Unfortunately, these changes have also magnified the freezing problem, since they create angles and obstructions that allow frozen chips to stick to the trailer more easily. Freezing problems are most common in the drop belly, on the slope leading out of the drop belly, and in the front corners of the trailers. These locations are exposed to the least force when the chips are unloaded at the dumper, so less freezing is required before problems arise.

Costs

There are two possible approaches to dealing with frozen loads, each with its own cost. The first involves simply accepting decreased payload potential; every kilogram of chips frozen into the trailer is a kilogram of lost payload during future trips. With a contractor profit margin of 5 to 10% of revenues, leaving frozen chips in the full drop-belly of a B-train or waist high on the front wall could eliminate all or most of this profit. To determine whether this was happening, FERIC obtained average tare weights for trucks in winter and in summer from the files of a mill in northwestern Ontario. The winter tare weights averaged 550 to 2000 kg higher than those in the summer, with an overall average tare weight increase of almost 1200 kg. Although some of this change may represent the accumulation of snow and other external parasitic weight, the majority of the calculated increase likely represents frozen chips, given that chip trailer designs reduce the risk of snow accumulation and that the units studied traveled primarily on highways.

The second approach involves loosening the chips, then dumping them again. The cost in this approach arises from the additional time required. Brief field observations showed that this approach required an average of 45 to 60 minutes per load when no precautions had been taken to prevent chip freezing. The time requirement was never less than 20 minutes, and sometimes reached 3 hours.

Since both approaches entail considerable costs, FERIC compiled a set of "best practices" to mitigate freezing problems and described additional preventative measures that can further reduce the risk.

Best practices: preparing the equipment for winter

As is true for any other situation, preparation and education can greatly reduce the magnitude of the potential problems. This section summarizes several best practices recommended by truckers who actually use them to reduce the problem of frozen loads.

Trailer coverings

Since the presence of snow, ice, or water in the trailer before loading contributes to freezing, truckers should make every effort

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to keep the trailer floor dry. Truckers who operate with net covers during the summer should switch to solid tarpaulins in winter, as these do a better job of keeping water, snow, and ice out of the trailer while travelling empty or parked outdoors. In addition to excluding water and snow, tarps also tend to last longer than nets, and will provide better aerodynamics (i.e., will improve fuel efficiency). However, the tarps must be kept in good condition and equipped with sufficient straps and other components to keep them tightly in place (Figure 2).

Trailer interiors

The condition of the trailer's interior strongly affects how often freezing problems will occur. Every contractor we interviewed told us that brand new trailers usually required minor modifications to correct problem areas and that older trailers tended to develop more problems with frozen loads. When you purchase a new trailer, inspect it for problem areas such as rough spots, dents, and unprotected ribs; with older trailers (more than 3 or 4 years old), inspect the trailer interior annually in late summer so you can spot any developing problems and repair them. Look for rough spots in the paint, scrapes, dents, or rust, as well as unnecessary right angles and any obstructions that could be minimized or removed.

Scrapes, dents, and rust spots result from normal wear and tear, and can create increasingly frequent or serious freezing problems over time. Experience will tell you when the interior should be repainted, and keeping good records will help your planning. Record the number of frozen loads you must deal with each season and the cost of fixing each problem to help you predict when repairs are warranted. For example, an increase from year to year can provide a valuable warning, although changing conditions from one season to the next could be partially responsible for this increase. You can also compare older trailers with newer ones or with newly repainted trailers during the same season to eliminate variations in weather as a factor, but even a small design difference in the trailers can significantly affect the frequency and severity of the freezing problems. A better approach might be to combine the two methods.

To keep these records, drivers should record when they had to dig out a load and how much time they lost doing so. They should also monitor the trailer's tare weight and compare it with recent average summer tare weights to get a feel for the cost of not digging out the frozen portions of a load. (Small weight increases may result from parasitic weight such as snow and ice, but larger weight increases are more likely to

Figure 2. (*Left*) A tarpaulin in poor condition will contribute to freezing problems. (*Right*) A well-maintained tarpaulin, properly attached to the trailer, will minimize freezing problems.

represent frozen chips.) These data should let you compare the cost of refinishing a trailer's interior versus doing nothing. A good rule of thumb for this comparison would be to assume that the refinished interior will last about half as long as the original finish, since it is usually less resistant.

Chip van interiors often contain many right angles, including where the floor meets the wall and at the front of the drop belly. Unfortunately, right angles and any angle smaller than 90° create high-risk spots where freezing is likely to occur due to increased exposure to the cold surfaces. Small frozen areas begin to grow in these corners, and can expand to become considerably larger problems over the course of a few trips. Rounding out these corners by attaching a plate as narrow as 5 cm wide in the corner, installed at a 45° angle, will convert a single sharp 90° angle into two gentler 135° angles (Figure 3), and will greatly reduce the risk of freezing with minimal payload loss. Ideally, trailer manufacturers should address this problem at the design stage, but welding small plates in critical corners can be a satisfactory post-sale compromise. The most critical points tend to be:

- the front of the trailer, where the front wall meets the floor;
- from the floor to halfway up the corners where the side walls meet the front wall;
- the first metre away from the front wall along the floor, where the side walls meet the floor; and
- any corners inside the drop belly.

Even small obstructions to the dumping of a load can compound freezing problems. Often, you can do little to fix the problem (e.g., with the structural ribs on the inside walls of the trailer), so carefully consider the potential seriousness of the problem when you purchase a new trailer; look for designs that minimize the obstacle posed by these structural elements. Common obstructions you can avoid include an overly steep slope at the end of the drop belly nearest the back doors, and lips at the edge of the back door. The closer the slope is to vertical, the more of a blockage it represents during unloading on the dumper, and the less freezing that is required before a problem arises.

When freezing problems do occur in the drop belly, it may be possible to build a temporary insert that widens the angle of the slope that leads out of the belly during the winter, and that can be removed in summer to maximize payload. Work with light materials such as wood or aluminum, and make the exposed surface as smooth as possible (ideally, a painted surface). Lips around the van's doors, though less common, can cause serious problems when present. The lips create both a right angle and an obstruction at the door, often right at the end of the rear slope of a drop belly. The resulting initially small freezing problem can create larger problems if it begins to block the exit of chips from the drop belly. To reduce this problem, smooth out these lips by welding an angled plate across them (thereby creating a smoother path for the chips) or change the floor's slope so that it comes out flush with the edge of the lip.

For refinishing the trailer to be economically justifiable, the cost must be less than or equal to the cost of freezing problems over the working life of the finish.

Plates used to round out corners should be small so as to avoid adding excessive weight to the trailer or significantly reducing volume.

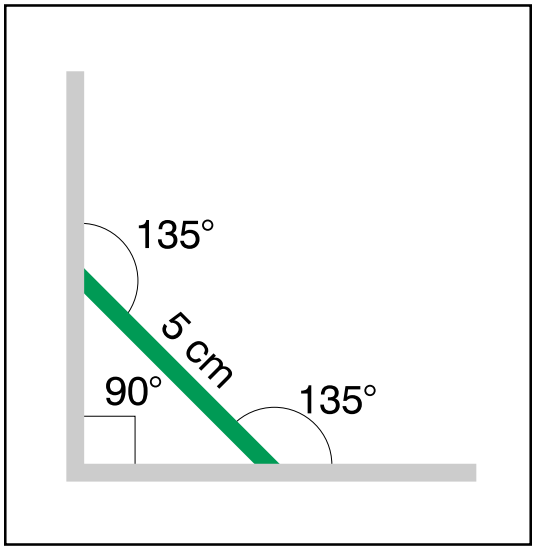

Figure 3. Welding a small plate into corners at a 45° angle reduces the sharpness of the angle, thereby reducing the risk of freezing.

Proper tools and knowledge for drivers

Once the trailer is ready for the winter season, drivers should obtain a few simple tools to deal with small problems before they become big ones and should understand how to recognize these problems. Every truck should have a broom plus a shovel or pitchfork, and trailers should provide easy access to permit cleaning. Drivers must learn to clean the trailers after every trip and should learn the loading tricks that will reduce unloading problems. Because of the time required by such maintenance and changes in loading practices, employers should provide incentives to encourage drivers to cooperate.

Since the presence of water, ice, snow, or chips frozen to the inside of the trailer before loading will compound freezing problems, drivers must ensure that the trailer is clean before loading. Many drivers only inspect the trailer through its sample doors as they remove the tarpaulins and must subsequently shovel out the trailer when they unload. A better approach would be to enter the trailer and clean it with a broom and a shovel or pitchfork. It's important to remove as much snow and ice as possible because the weight and warmth of a load of chips will partially melt the snow and ice, thereby creating moisture that later freezes the chips into the trailer. When dealing with chips frozen in the trailer, simply knock them loose and spread them over areas of the floor that commonly freeze. Provided that no major temperature fluctuations occur during the trip, these frozen chips can act as an effective barrier to freezing between the chips being loaded and the cold trailer. In contrast, if they're left frozen to the trailer they act as a rough surface that compounds the freezing problem over time. It should take only a few minutes to check whether a trailer must be cleaned, but failing to spend this time can cost hours of digging over the course of the winter.

If your van is loaded by a loader rather than from an overhead bin or with a blower, you should take a few additional measures to reduce freezing problems. Since loaders usually work from stockpiled chips, snow on the surface of the pile and warm, damp chips from the center of the pile can both pose problems; the former will melt under the weight of the load and refreeze, and the latter contain enough moisture to freeze during travel. Thus, neither makes for a good first layer in the van. Clean, dry, frozen chips make the best first layer (the first 15 to 30 cm) in the van, and it is usually safe to add other chips with greater moisture contents on top of this layer.

Asking the loader operator to avoid warm, damp, snow-covered, or icy chips in the first layer requires diplomacy. Loader operators are most likely to cooperate if they understand why you need their help to do your job efficiently.

Drivers will only clean trailers if it's easy to get inside. Some manufacturers build trailers with a door at the front so drivers can easily and safely enter the trailer to perform cleaning and maintenance.

Preventative measures

Using the "best practices" described in the previous section will reduce but not eliminate the risk of frozen loads during winter haul operations. To further reduce these freezing problems, FERIC explored various other preventative measures that drivers can take when temperatures approach freezing. However, these preventative measures will be of little or no help unless they're combined with the best practices described earlier.

This section presents three types of approach: the use of a stationary or onboard spray system for delivering antifreeze, a portable manual spray system, and the use of special tarpaulins in the trailer's interior. Which approach you choose will depend on your operation and what the mills you serve will accept. If you choose an antifreeze (chemical) approach, confirm with your mills that the chemical you choose won't cause problems for their pulping process. (They may need to test a small sample in the lab.) Agreeing on a solution that your

customer will accept is particularly important if you choose to invest in a mechanized approach. Table 1 summarizes the relative effectiveness of various approaches as well as the effectiveness of the antifreeze solutions that FERIC tested. Details of other approaches that proved less successful are described in Table 2.

Table 1. The effectiveness of tarpaulins and other approaches based on the application of antifreeze solutions (R = recommended, E = effective, N = not recommended)

	Method				Chemical		
	Stationary spray station	On-board sprayers	Portable spray system	Interior tarpaulin system	$MgCl_2$[a] with corrosion inhibitors	Windshield washer fluid	Ice Barrier[b]
Owner-operator	N	R	E	E	R	E	E
Small fleet (3 or fewer trailers)	E	R	N	E	R	E	E
Medium fleet (3 to 6 trailers)	R	E	N	N	R	E	E
Large fleet (more than 6 trailers)	R	N	N	N	R	N	E

[a] Details on these products are contained in the following report: Webb, C.R. 1997. Reclaiming lost payload: extracting frozen chips from chip trailers. For. Eng. Res. Inst. Can. (FERIC), Vancouver, B.C. Tech. Note TN-262. 12 p.

[b] **Ice Barrier 818™.** Manufactured and distributed by West Penetone Inc., 10900 Secant St., Ville d'Anjou, Que.
Ice Barrier 818™ is designed to be applied before icing conditions develop, and produces a film barrier that prevents ice from forming a firm bond with metal surfaces. Thus, it allows easy removal of frozen materials. When applied at least several hours before loading, even chips that freeze will still slide easily out of the trailer because they cannot bond to the floor and walls of the trailer. Users must monitor the product's effectiveness, since the product wears away over time and gradually becomes ineffective.

Table 2. Additional, less-successful preventative measures

Preventative measure	Problem
Carbon-based paint on the trailer's interior walls	Was often effective for only a few months due to abrasion, and the cost was too high to justify a second application that soon.
Insulation using a plywood trailer liner	Can be effective for medium-length hauls (2 to 3 hours) of products with severe freezing problems (sawdust or fine chips), but the high installation cost and lost payload and volume in the trailer make it difficult to recommend.
Thin Teflon or other plastic liner	Can be effective, but is very expensive and few mills will allow trailers that use plastic in the interior (since plastic contamination is a major concern).
Onboard spray system with fixed nozzles	Too expensive because of the type and number of spray nozzles required.
Stationary spray station pressurized with air	High maintenance cost to keep the connections and spray nozzles working; freezing problems occurred with the system at temperatures below –20°C.

Stationary spray stations

A stationary spray station (Figure 4) lets drivers easily and effectively apply antifreeze chemicals at the beginning of a shift at the dispatch point. Such a system requires a bulk storage tank set up to feed the chemical into a pressure washer. The size of the tank required depends on the fleet size and how often you can obtain delivery of the chemical. The two operations we observed using this system had tanks large enough to last for 25 to 50% of the freezing season, and both used $MgCl_2$ with corrosion inhibitors. At the beginning of each shift, drivers pulled up to the spray station and applied the chemical to the van's floor and about halfway up the walls through the sample doors and rear doors, concentrating mainly on the front of the trailer and the drop belly.

This system is recommended for larger fleets, since the setup and maintenance costs are cheaper than purchasing several onboard systems and the system proved equally effective. We recommend using $MgCl_2$ with corrosion inhibitors because this solution is most cost-effective. The product is inexpensive (less than $0.40/L) and costs $6 to $12 (15 to 30 L) per application for a B-train, versus $4 to $8 (10 to 20 L) for a semi-trailer. We found that this product worked best with a light application.

It's instructional to compare these costs with the cost of shoveling out frozen chips. At about $70/hour (operator and vehicle costs combined), the cost of the application ($8 maximum) would be recovered if just 7 minutes of shoveling is saved per trip. Given the 45 minutes typically required to shovel frozen chips out of a trailer and the added potential penalty of lost payload, using the spray station can obviously prove economical.

Windshield washer fluid does not work in this approach because it evaporates and drains away too quickly. For this fluid to be useful, the stationary sprayer would have to be installed at the loading point or the fluid would have to be applied via an onboard system. The Ice Barrier product, which can last for six to eight trips, is less attractive than $MgCl_2$ because of its cost. Tests showed that it can be as effective as the other products, but at a cost of $2.50 to $4.00 per litre, precise application and controlled application rates are essential to limit costs to $50 to $70 per application.

Figure 4. A stationary spray station. Subsequently, the pump was set in an enclosure to protect it from the elements.

Onboard spray systems

Onboard spray systems (Figure 5) let drivers apply an antifreeze chemical when needed, usually right before loading. In this system, a high-pressure tank similar to the wet tanks used with brakes is installed on either the tractor or the trailer. This tank should hold at least 25 to 30 L so as to contain enough antifreeze for one or two applications. The tank can be larger, but would then increase the weight you must carry and would cost more; balance this extra cost with the need to refill smaller tanks more often.

Figure 5. The components of an onboard spray system. (*Top*) A pressurized tank on the trailer. (*Center*) The sprayer's spray nozzle. (*Bottom*) Applying the antifreeze chemical.

The installed tank should have a fill spout (with a pressurized cover), an air input (controlled by a ball valve) at the top, and an output at the bottom. Run a standard ½-in. (1.3-cm) plastic air line from the output to a quick-connect point (similar to hydraulic connectors) at a convenient location on the trailer; on B-trains (Figure 6, left), this would usually be at a top rear corner of the lead trailer, at the catwalk between the two trailers, whereas on semi-trailers (Figure 6, right), the position would usually be at the front of the trailer. For a semi-trailer, the line can run up the trailer's front wall and attach to a quick-connect point near the top of the wall. For a B-train, the line can run up the front wall of the lead trailer, through the front wall, then along the wall to the back of the trailer; the quick-connect point should sit just under the top rail near one side wall on the rear of the lead trailer to avoid the need for a connection to the rear trailer. An air-blower nozzle equipped with at least 1 m of flexible hose will attach to the quick-connect. When drivers arrive at the loading point, they open the ball valve to charge the tank with air. They then remove the tarpaulins, attach the nozzle to the quick connect, and apply the chemical to the van's floor and halfway up the walls, concentrating mainly on the front of the trailer and on the drop belly, working downwards from the top of the trailer. For B-trains, both trailers can be treated by working from the catwalk.

We recommend this system for smaller fleets since it can be more convenient, and at a cost lower than or equal to that of a stationary sprayer. It also offers flexibility in the choice of chemicals, since applications can take place right at the loading point. We recommend $MgCl_2$ with corrosion in-

hibitors because it's slightly more effective than windshield washer fluid in extremely cold weather and lasts longer after application. The cost per application is comparable to that with a stationary sprayer. Windshield washer fluid can be an effective alternative if applied no more than 30 minutes before loading. It is often easier to find than the other products, and costs less (around $0.30/L). The Ice Barrier product could be used, but the cost of this product and the resulting need for increased control during application make it more economical with a manual spray system.

Portable spray systems

A portable manual spray system should only be used where applications are infrequent and few trailers must be sprayed. With the manual system, drivers apply the chemical using a basic garden sprayer. Drivers enter the trailer with the sprayer and apply the chemical to the floor and about halfway up the walls, concentrating mainly on the front of the trailer and the drop belly.

This method is an effective alternative for a small fleet or when using Ice Barrier, since this product only needs to be applied infrequently (every six to eight trips). The ability to control how much of the product is applied and where can justify the higher cost of Ice Barrier. Using the other two products with a manual approach is not recommended because the time and effort required make the procedure unattractive to busy drivers.

Interior tarpaulin systems

Tarpaulins represent a purely mechanical approach to the problem. In this approach, a special heavy-duty Teflon-coated tarpaulin such as the Magic Carpet™ brand attaches to the interior of the trailer and creates a slick, flexible surface that chips have difficulty sticking to when frozen. The tarpaulin lies flat on the floor, starting at the

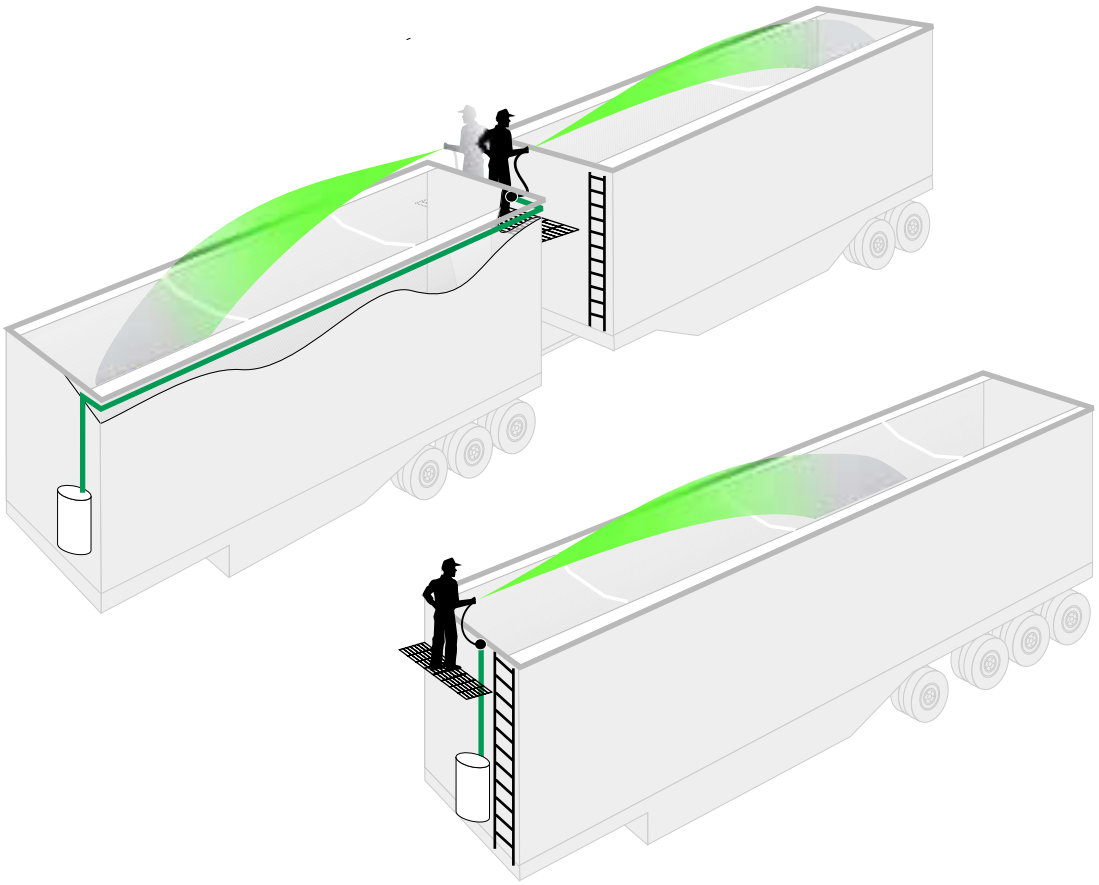

Figure 6. Connection points for onboard spray systems on a B-train (*left*) and semi-trailer (*below*).

bottom front corner of the drop belly and running to the top of the slope that leads out of the drop belly; the tarpaulin only attaches at the bottom front edge of the drop belly. (Suppliers must receive accurate measurements of the trailer's floor for the tarpaulin to fit the trailer properly.) When the trailer dumps, the tarpaulin tends to straighten, thereby breaking free of the floor and letting the load slide more easily out of the drop belly.

This approach can be an effective alternative for any size of fleet, but proper installation is vital to prevent loss of the tarpaulin, and drivers must ensure that chips don't build up under the tarpaulin and create problems. The system costs about $1000 for a B-train and just over half that much for a semi-trailer. In FERIC's trial, installation proved difficult and the tarpaulin was lost part-way through the winter, but the manufacturer claims that a properly installed tarpaulin will last 2 to 3 years. Before your purchase, make sure that your customers approve of the presence of a tarpaulin inside the trailer, since some will not accept the risk of pieces of the tarpaulin ripping off and entering the mill's chip furnish.

Implementation

The best practices and other preventative measures described in this report will help reduce the severity of the freezing problems you encounter, but are unlikely to completely eliminate them. The following measures can help reduce the magnitude of the problem:

- Address the time required to keep trailers clean in the winter during contract negotiations. Drivers will cooperate better if they have an incentive to do so.
- Cover open trailers with solid tarpaulins rather than nets when you expect freezing conditions, and ensure that the tarpaulins remain in good condition and can be tightly attached to the top of the trailer.
- When you purchase a new trailer, inspect its interior so you can identify and correct any problem areas. Look for obstacles to the free flow of chips during unloading, and aim for a design that contains as few obstacles as possible. As the trailer ages, inspect the interior every fall so you can fix any developing problems.
- Provide appropriate tools for removing frozen chips (e.g., a broom plus a pitchfork or shovel) and teach drivers the importance of using these tools before loading and after every trip.
- Avoid loading icy, snow-covered, or warm and damp chips as the first layer in the van. These chips are most likely to freeze to the floor and walls and cause problems during unloading.
- Consider using mechanized (onboard or stationary) or portable manual antifreeze sprayers to reduce the risk of freezing. If you choose this approach, confirm that your customers will accept the chemicals you've chosen (i.e., that the chemicals won't interfere with the mill's pulping process).
- A special tarpaulin mounted in the drop belly can prevent chips from freezing to the floor of the trailer. If you choose this approach, confirm that your customers will accept the presence of a tarpaulin inside the trailer, since detached pieces of the tarpaulin would contaminate the mill's chip furnish.

Reducing freezing problems often requires a compromise between maximizing payload and minimizing freezing. Always compare the cost of the solutions with the benefits they provide so you can make an informed decision. Where a solution reduces payload or volume, consider a temporary solution that can be removed during the warmer months.

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