

"EVALUATION OF A SOLID LUBRICANT APPLIED WITH A PROTOTYPE HY-RAIL VEHICLE APPLICATION SYSTEM,"

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TD 95-009**

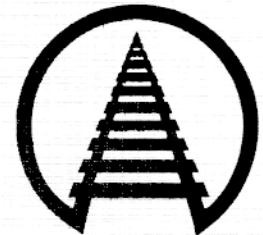
Summary

The use of a solid lubricant applied by a hy-rail based system was evaluated at the Transportation Technology Center, Pueblo, Colorado, to determine if it could provide effective and durable lubrication under heavy axle load operating conditions.

Tests were conducted on the High Tonnage Loop at the Facility for Accelerated Service Testing and no top of rail contamination or migration of the solid lubricant was noted. The hy-rail application system demonstrated improved control of friction at selected locations on the railhead. It is estimated, however, that the system's lubrication effectiveness — gage face friction levels below 0.35μ — only lasted half as long as conventional track grease.

Solid lubricants offer the potential of improved control of unwanted lubricant migration, but require precise application alignment to ensure deposition at the desired location.

Performance of a solid lubricant applied with a prototype fixture suggested that a hy-rail system could be used to apply such a material. However, transfer rate and durability of such materials require improvement to match performance of conventional track greases on the gage face.



Suggested Distribution:

- Motive Power
- Train Handling
- Maintenance of Way
- Locomotive Dept.

**Association of American Railroads
Research and Test Department**



INTRODUCTION AND CONCLUSIONS

The Association of American Railroads (AAR) has evaluated alternative application systems and lubricants as part of its program to control rail/wheel friction. Because conventional lubricants tend to migrate onto the top of rail, interest in alternative lubricants is growing. Truck steering can be affected by improper lubrication; therefore, an improvement in control of migration over that of conventional lubricants is desirable. Previous AAR experience with solid lubricants has shown that, once applied, there is little tendency of migration to the top of rail.

Prior to this evaluation, most solid lubricants have been applied using a type of locomotive flange lubricator. However, results using available materials have suggested that transfer rates from the lubricant to the rail were insufficient for heavy haul freight service. In addition, experience to date in freight railroad use has shown poor mechanical reliability of applicators designed for solid lubricants. Applications have generally been limited to transit operations and short line service, where inspection and adjustment can be more easily controlled.

A limited evaluation of a prototype hy-rail vehicle application system that applies solid lubricant was conducted at the Transportation Technology Center (TTC), Facility for Accelerated Service Testing (FAST). Results suggest that with increased transfer rate and proper alignment of the solid lubricant, gage face rail lubrication conditions approaching that of traditional greases can be obtained. This performance comes without unwanted lubricant migration to other parts of the rail, or excess product wasted onto the ballast. Before solid lubricants can replace grease, however, additional product development in transfer rate of the material and physical design of the application system are needed.

Selection Process

Increased use of hy-rail based lubrication by member railroads led AAR to evaluate a solid

lubricant. A hy-rail system would, by design, apply lubricant directly to the rail gage face without first being applied to the locomotive flange.

By eliminating the extra transfer process, lubricant could be applied directly to the rail if the locomotive wheel is flanging or not. This is considered even more critical with newer generation radial truck locomotives that are designed to reduce flanging. By eliminating the locomotive flange transfer function and using the direct-to-rail process followed by hy-rail systems, the application environment becomes less severe and easier to control.

The AAR selected a solid lubricant that had been previously evaluated as an onboard locomotive flange lubricator, and is in use by several transit and shortline operations, for this prototype evaluation.

Given a known lubrication effectiveness (insufficient for use in its present configuration when used on a locomotive flange applicator in heavy freight service), the product was applied using a hy-rail concept. By comparing results to previously conducted hy-rail application system evaluations, the performance of a solid lubricant applied by this system can be assessed.

Hy-rail Applicator

In order to evaluate the concept of a solid lubricant "hy-rail" applicator, a mockup of an application system was fabricated. A hy-rail vehicle could not be obtained in enough time to allow for modifications and testing. Therefore, the applicator fixture was reconfigured so it could be attached to a track gang push cart, which was pulled by a heavy duty hy-rail vehicle during the 2-day test period.

Field Test Evaluation

The test was conducted on the High Tonnage Loop (see Exhibit 1). All evaluations were performed on Section 07, a 1,000-foot, 5-degree reverse curve with 300-foot spirals and 4 inches of superelevation. Under standard FAST operations, this rail does not receive direct high rail gage face



lubrication application. Normal train speed is 40 mph. Lubrication is normally applied to the top of high rail by a special lubricator located near Section 25; however, this unit was disabled during test runs.

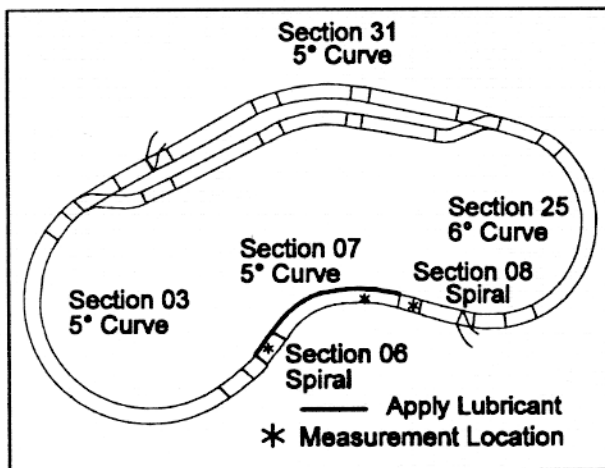


Exhibit 1. FAST/HTL

An in-track field evaluation was performed in November 1994. Normal FAST operations were conducted but without top of rail lubrication. The test procedure was as follows:

1. Prior to train operation, lubricant was applied to the gage face of Section 07 by repeated passes of the lubricator cart.
2. After 10 passes to apply solid lubricant, the cart and hy-rail tow vehicle were removed from the FAST loop and train operation resumed.
3. Friction data was collected with a tribometer after every other train pass. Gage face friction was the primary measurement, although top of rail data was also taken on a periodic basis.
4. When dry rail (gage face friction higher than 0.35) was obtained, the FAST train was halted and lubrication application repeated.

RESULTS

Measurements of reduction in gage face friction after a single pass with the lubricator cart were made before train operations began. It became apparent that due to the physical shape and transfer rate of the lubricant, it would be necessary to make multiple passes of the lubricator cart before each sequence of train operations in order to transfer a sufficient amount of lubricant to the rail.

Exhibit 2 shows gage face friction with respect to application pass for test sequences 1, 2 and 3. Note that no train passes occurred between application passes. The data suggests gage face friction was noticeably reduced for each applicator pass during the first six passes, with only a marginal improvement for subsequent passes. For experiment control purposes, each application sequence involved 10 passes of the lubricator cart between train operating periods.

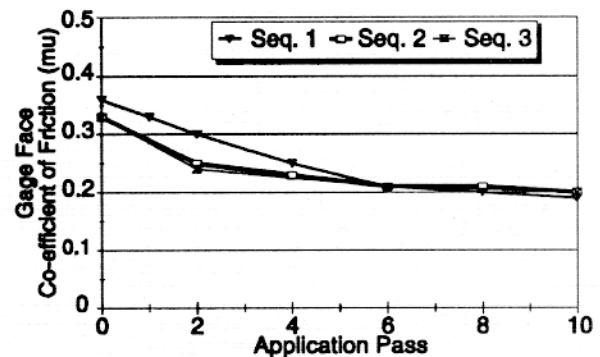


Exhibit 2. Gage Face Friction vs. Application Pass

Starting ("dry") gage face friction was reduced from 0.33 - 0.36 to about 0.2 after each 10 pass application sequence. With the lubricant and application system evaluated, the lowest friction level obtained was 0.2. Typical FAST conditions, using conventional lubricants, typically provide a gage face friction between 0.09 and 0.15.



After 10 application passes with the lubricator cart, train operation was restarted and gage face friction readings taken every lap. This data is shown in Exhibit 3 and shows gage face friction with respect to axle pass. Also shown for reference is hypothetical friction data for a traditional grease with a hy-rail system. Because previous hy-rail tests at the TTC were conducted before a tribometer was available, the friction data is estimated based on alternative measurements (equivalent performance based on rail temperature rise and instrumented wheel set data). Conventional track grease applied by a hy-rail lasted significantly longer (at least double the axle passes) than the solid lubricant.

It is important to note, however, that during the conventional lubricant tests, significant top of rail contamination was observed. However, during the solid lubricant hy-rail tests, no effective top of rail lubrication or contamination was measured. During the dry down, after application of the solid lubricant, some lubricant material was trapped in the rough contact surface of the gage face which gave the appearance of a smoother gage face.

Recommendations for Future Development

Solid lubricant applied directly to the rail lasted approximately half as long as conventional grease. However, no top of rail contamination was observed. With the configuration evaluated, the solid lubricant required 10 application passes in order to transfer a sufficient amount of lubricant onto the rail in order to obtain observed performance.

Future development of solid lubricants for use by hy-rail applicators is needed. Improved durability and a much higher material transfer rate is essential in order to provide gage face

lubrication as effective and long lasting as conventional greases. The solid product does not show any tendency to migrate; therefore, alternatives for controlling top of rail friction, such as adhesion modifiers, could also be incorporated into an application system. Other application vehicles, such as a rail grinder, which operates at very slow speeds, might provide a platform for higher lubricant transfer rates by allowing a configuration with larger pressures and additional applicator sticks.

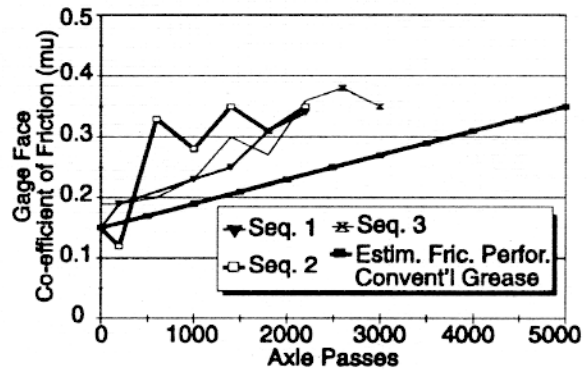


Exhibit 3. Gage Face Friction vs. Axle Pass

Additional field influences, including application over existing contamination such as residual grease, dirt and other coatings found in revenue service will be required. Future evaluation of solid lubricants is warranted if laboratory testing comparing alternative materials to those used in this evaluation exhibit higher transfer rates and more durability.

Acknowledgments

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Note: Contact Richard Reiff at (719) 594-0581 with any questions or comments about this document.

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