Evaluation of MPL Technology Solidstick™ Lubricant Locomotive Flange Lubrication System

Prepared for MPL Technology, Inc.

By Scott Gage
Transportation Technology Center, Inc.

Éa subsidiary of the Association of American Railroads
P. O. Box 11130, Pueblo, Colorado 81001

February 2001 (rev. 5-07-01)
P-01-007

EXECUTIVE SUMMARY

Evaluation of the MPL solid stick lubricant using a four locomotive (three locomotives lubricating) 58 car train on a 2.77 mile closed loop at the Transportation Technology Center (TTC), indicated approximately 40% reduction in mechanical energy demand between dry and lubricated rail. The train was operated at a consistent speed averaging between 38 and 39 miles per hour. The test loop includes three 5-degree curves and one 6-degree curve with limited tangent track between each curve. Lubrication was applied using 12 stick lubricators, 6 on each side of the locomotives. A stick was applied to the lead axle on each truck on the first, second and fourth locomotives. Mechanical energy data was collected using an instrumented coupler located at the trailing end of the last locomotive. During the initial 39 miles (14 laps) of dry to steady state lube cycle, approximately 1 inch of lubricant was consumed on each solid stick. After an additional 30 miles (10 laps) of steady state lubricated operation, stick consumption had dropped to approximately °-inch per stick. An additional 39 miles (14 laps) were run with wayside lubrication and solid sticks together. Average stick wear was measured at ![-inch with both systems operating together.

Lateral forces were also monitored in the 6-degree curve during the test. Evaluation of these forces indicated there was no significant change between dry and lubricated operation with the solid sticks and that the lubricant was not migrating to the top of the high or low rails.

INTRODUCTION

MPL Technologies, Inc. contracted Transportation Technology Center, Inc. (TTCI) to perform a lubrication evaluation on the MPL lubrication system. The MPL system is a locomotive mounted, solid-stick flange system that uses specially designed brackets to hold a solid stick cartridge into the throat of the flange area. This test was to duplicate as closely as possible the conditions seen during the Association of American Railroads sponsored Top of Rail (TOR) lubrication tests performed in 2000. The test was performed on the FAST/High Tonnage Loop using essentially the same train and locomotives as was used for the TOR testing. Energy savings results from the MPL test were comparable to those seen during the TOR lube test.

OBJECTIVE

The objective of this test was to perform a "typical" lubrication test on the FAST/HTL and record mechanical energy through the use of an instrumented coupler to compare energy savings from a dry to lubricated condition.

PROCEDURES

LUBRICATION SYSTEM INSTALLATIONFOR SAFETY REASONS, TTCI MONITORS LATERAL AND VERTICAL FORCES IN AT LEAST ONE CURVE TO DETERMINE IF THE LUBRICATION IS HAVING A DETRIMENTAL EFFECT ON TRUCK CURVING. THE 6-DEGREE CURVE ON THE HTL IS EQUIPPED WITH A LOAD MONITORING STATION AND DATA WAS COLLECTED AT THAT LOCATION DURING TESTING.

The primary objective for this test was to document steady state energy savings with the solid stick lubricant so no friction data was collected. All comments on the condition of the gage face and the buildup of lubrication were observational only.

For safety reasons, TTCI monitors lateral and vertical forces in at least one curve to determine if the lubrication is having a detrimental effect on truck curving. The 6-degree curve on the HTL is equipped with a load monitoring station and data was collected at that location during testing.

The primary objective for this test was to document steady state energy savings with the solid stick lubricant so no friction data was collected. All comments on the condition of the gage face and the buildup of lubrication were observational only.

TEST CONDUCT

The test was conducted on TTC's HTL (Figure 1). The HTL is a 2.7-mile loop with two 5-degree curves, a 5-degree reverse curve and a 6-degree curve.

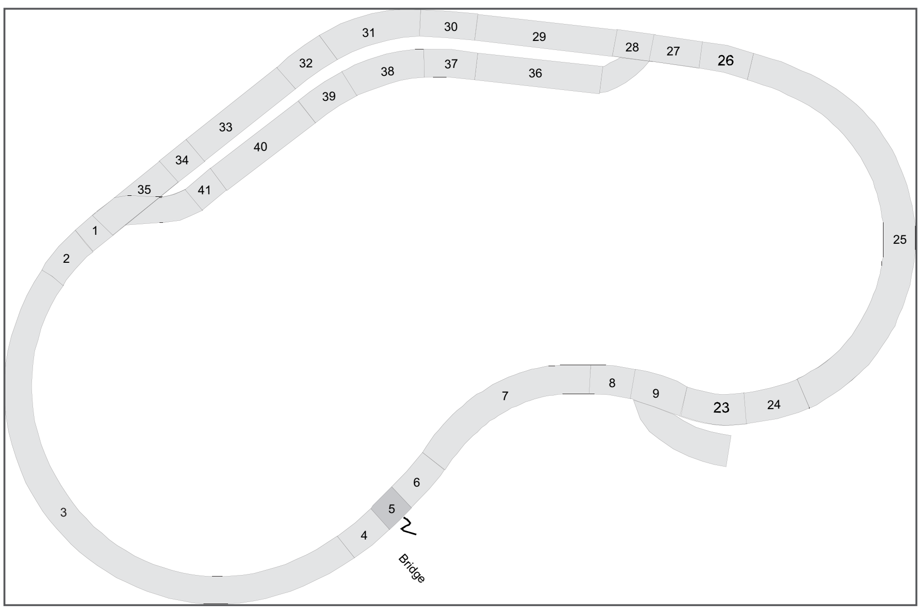


Figure 1. FAST HTL

The test was conducted using one GP 39-M, three GP 40-2 and 58 trailing cars. The cars were loaded 125-ton gondolas (weight on rail of 315,000 pounds) with standard three-piece trucks. Consist tonnage was 9,135 tons with a total train weight of 9,597 tons.

All test runs were made in a clockwise direction with the data collection beginning/ending at the FAST bridge. Average speed lap to lap was held consistent at 38 to 40 miles per hour. Air brakes were not used to stop the train. All braking was

The test was conducted using one GP 39-M, three GP 40-2 and 58 trailing cars. The cars were loaded 125-ton gondolas (weight on rail of 315,000 pounds) with standard three-piece trucks. Consist tonnage was 9,135 tons with a total train weight of 9,597 tons.

All test runs were made in a clockwise direction with the data collection beginning/ending at the FAST bridge. Average speed lap to lap was held consistent at 38 to 40 miles per hour. Air brakes were not used to stop the train. All braking was done dynamically by the locomotives. The test was conducted during night time operations with an average air temperature of 5-degrees F. The following table is a description of the test runs:

Table 1. Test Log

LAP	CONDITION	COMMENTS
1-33	Dry down	Removing residual lubrication from gage face in curves
34-42	Baseline dry	Data collection to measure & baseline “dry” energy
43	Dry	Stop train to install lubrication sticks
44-45	Lubricating	Accelerating to test speed; Data collection turned on
46-56	Lubricating	Data collection to measure energy to steady state.
57	Lubricating	Stop to measure initial wear of solid sticks
58-59	Lubricating	Accelerating to test speed
60-66	Lubricating	Data collection to measure energy while lubricating
67	Lubricating	Stop for second measurement of stick wear – End of Test

RESULTS

MECHANICAL ENERGY

Figure 2 shows the lap by lap mechanical energy results of the dry/baseline and lubricated conditions.

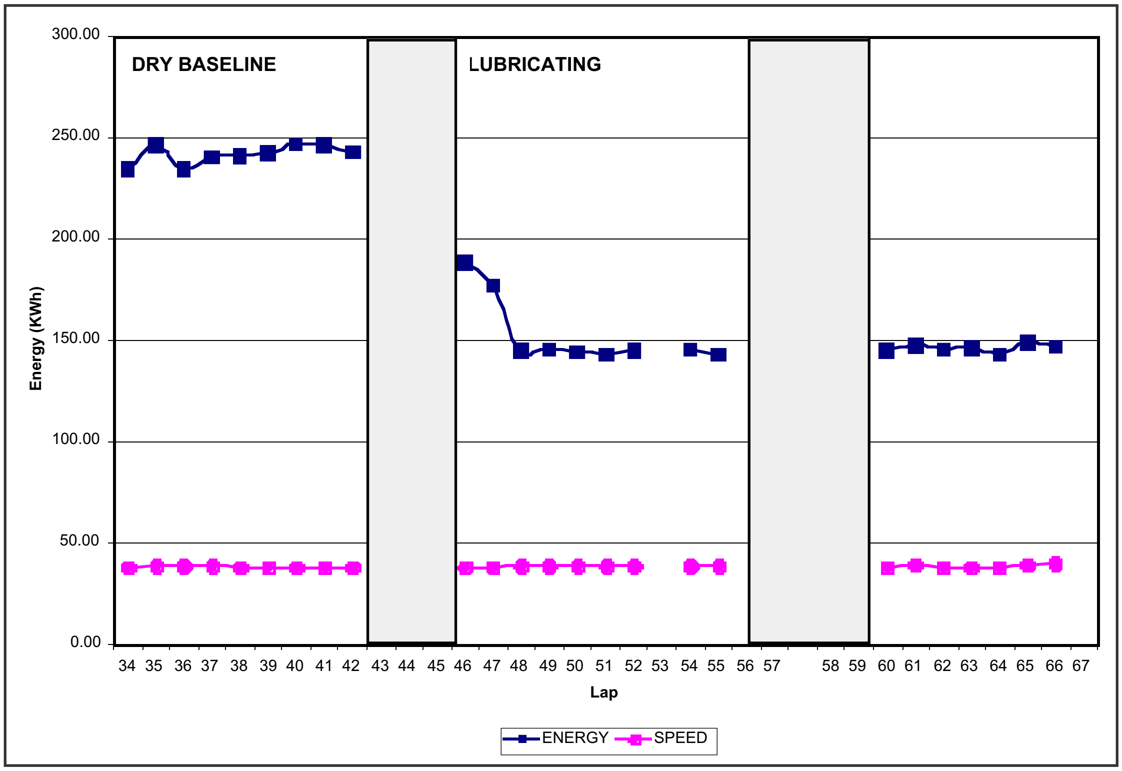


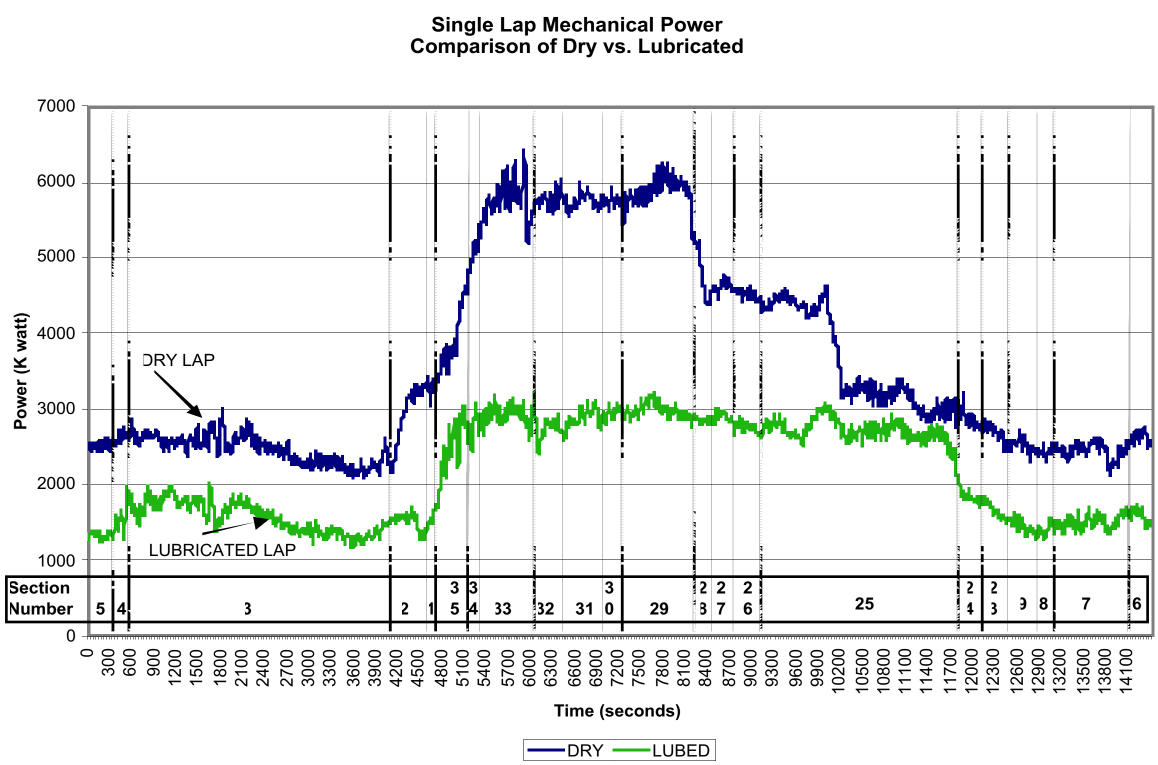
Figure 2. Per Lap Mechanical Energy

Average energy during the dry/baseline runs, collected on laps 34-42, was 241.74 kWh. After the solid lubrication sticks were installed (lap 43) energy showed an immediate drop once the train was at test speed. Energy for the second lap after start of lubrication dropped to 188 kWh and to 177 kWh after the third lap. By the fourth lap energy readings had dropped to what was established as the approximate steady state condition (144.3 kWh). Average energy during the lubricated running was calculated from all complete laps at test speed (laps 46-56 and 60-66). Average energy for the lubricated period was 145.23 kWh. Comparing the average dry/baseline energy (241.74 kWh) with the average steady state lubrication condition (145.23 kWh) gives an average energy savings of 39.9%. To verify the energy calculations, average coupler force was also analyzed and showed an average force reduction of 39.7%.

The two shaded rectangles in Figure 2 indicate times when the train was stopping and accelerating after installing and measuring the solid sticks.

Figure 3 shows the power seen at the instrumented coupler comparing a typical dry lap and a typical lubricated lap; it indicates that a significant power reduction was seen throughout the 2.7-mile HTL loop. This is due to the lower throttle position or "notch" required to maintain speed.

Figure 3. Single Lap Mechanical Power - Dry vs. Lubricated
***Refer to Figure 1 for section number locations**



LUBRICANT CONSUMPTION

Table 2 show the wear of each stick throughout the test, and Figure 4 shows the cumulative average stick consumption for the entire test. The right side measurements were on the locomotive wheels that were riding on the inside rail of the loop. The inside rail is predominantly the low rail of the curves. The left side measurements are on the locomotive wheels that run predominantly on the high rail of the curves. Measurement 1 was taken after the initial 14 laps (39 miles) starting from dry rail to steady state lubricated conditions. Measurement 2 was taken after an additional 10 laps (27 miles) of running at steady state conditions. Measurement 3 was taken after an additional 14 laps (39 miles) with wayside lubrication turned on.

Measurements indicate a substantial reduction in lubricant consumption after the rail has reached a steady state lubricated condition.

Table 2. Solid Stick Wear Measurements

		RIGHT SIDE INSIDE RAIL			LEFT SIDE OUTSIDE RAIL		
		MEAS 1	MEAS 2	MEAS 3	MEAS 1	MEAS 2	MEAS 3
LOCO 1	AXLE 1	0.875”	0.250”	0.125”	1.000”	0.250”	0.125”
	AXLE 3	0.875”	0.250”	0.125”	1.000”	0.125”	0.125”
LOCO 2	AXLE 1	0.625”	0.375”	*	0.750”	0.250”	0.125”
	AXLE 3	0.125” *	0.125” *	*	1.000”	*	0.125”
LOCO 3	AXLE 1	0.500”	0.125”	0.625”	0.750”	0.250”	0.125”
	AXLE 3	1.125”	0.125”	0.625”	1.000”	0.125”	0.625”

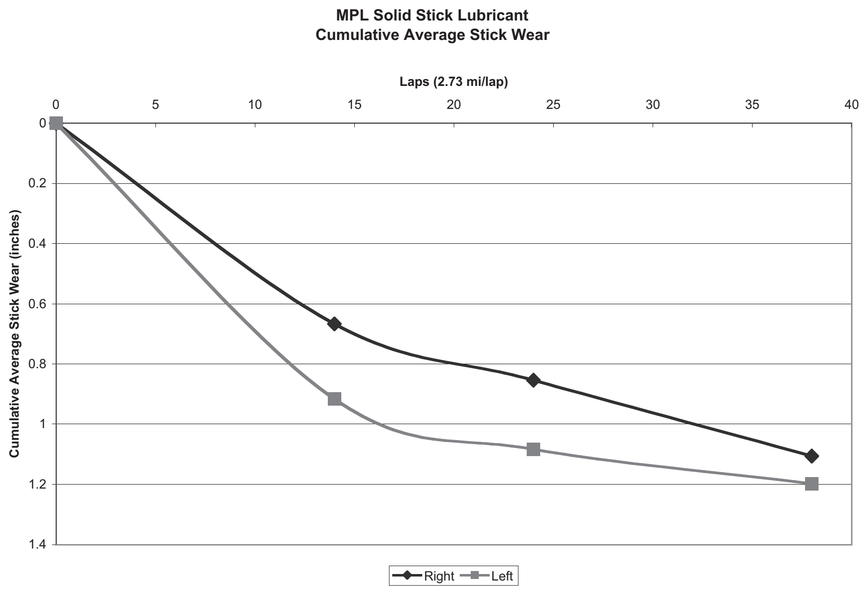


Figure 4. Average Stick Consumption

LATERAL FORCES

The following tables list average lateral forces for steady state dry, and lubrication with the MPL solid sticks:

Table 3. Dry/Baseline Average Lateral Loads

	Low Rail LateralForce (kips)	High Rail Lateral Force (kips)
MAX	21.20	16.12
MIN	1.68	-4.44
AVG	10.42	4.95

Table 4. MPL Solid Stick Average Lateral Loads

	Low Rail Lateral Force (kips)	High Rail LateralForce (kips)
MAX	21.57	16.71
MIN	1.46	-4.61
AVG	9.97	4.91

No significant effect was seen on lateral forces indicating that the solid stick lubricant was not migrating to the top of the high or low rail.

RAIL CONDITION

The comments in this section are observational only as documented by the TTCI Test Engineer.

During the dry down and dry/baseline phase of the test, the gage face of the 6-degree curve became rough. The train was emitting a high pitched squealing while traversing the curve indicating a very dry condition. This was verified by metal flakes from the gage face of the rail throughout the curve.

The condition of the curve was again documented after approximately 15 laps with the solid stick lubricators applied. Evidence of lubricant buildup was seen on the gage face as more laps were run. Although the gage face was still rough, no metal flaking was observed. The TTCI engineer observed that the first half of the train was quieter than the last half, indicating that the lubricant was working its way back through the consist. The train was still emitting a high pitched squealing as it traversed the curve, but not to the degree noted during dry/baseline running. With typical HTL wayside lubrication, the gage face of the rail becomes very smooth with little or no squealing from the train.